

**Field Demonstration and Method Validation of  
NRL Environmental Immunosensors**

**Center for Bio/Molecular Science and Engineering  
Naval Research Laboratory**

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## Acronyms

ABG	Ammunition Burning Ground at NSWC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (a.k.a. Superfund)
DARPA	Defense Advanced Research Program Agency
DNT	Dinitrotoluene
EDA	Ethylenediamine
ESTCP	Environmental Security and Technology Certification Program
GAC	Granulated activated carbon
HMX	1,3,5,7-Tetranitro-1,3,5,7-tetrazacyclooctane
HPLC	High pressure liquid chromatography
MDL	Method Detection Limit
NRL	Naval Research Laboratory
NSWC	Naval Surface Warfare Center
NSWC	U.S. Naval Surface Weapons Center, Crane Indiana a.k.a. NADCrane, NAVSURFWARCEN
ONR	Office of Naval Research
PAU	Peak area unit
PCMCIA	Personal Computer Multiple Computer Interface Accessory
QA/QC	Quality assurance, quality control
RCRA	Resource Conservation and Recovery Act
RDH	RDX hapten
RDX	1,3,5-Trinitro-1,3,5-triazacyclohexane
RI	Research International
RPD	Relative percent difference
RP-HPLC	Reverse phase high pressure liquid chromatography
RQL	Reliable Quantitation Level
SD	Standard deviation
SERDP	Strategic Environmental Research and Development Program
SPE	Solid phase extraction
SUBASE	U.S. Navy Submarine Base, Bangor Washington
TCE	Trichloroethylene
TNB	1,3,5-Trinitrobenzene
TNT	2,4,6-Trinitrotoluene
UMDA	U.S. Army Ammunition Depot, Umatilla Oregon



# **Field Demonstration and Method Validation of NRL Environmental Immunosensors**

**Center for Bio/Molecular Science and Engineering  
Naval Research Laboratory**

**August 27, 2003**

## **1. Introduction**

### **1.1 Background Information**

The major components in nearly all military munitions are TNT and/or RDX, compounds which are both a potential explosive hazard to remediation workers when present at high concentrations in soil and are toxic to humans at lower concentrations. The U.S. EPA has proposed a 'lifetime health advisory' level of 2.0 ng/mL TNT and RDX as the maximum limit for drinking water.<sup>1</sup> The DoD has more than 50 sites listed on the U.S. EPA Superfund list that are contaminated with explosives from munitions manufacture, storage, and demilitarization that do not meet these limits. TNT and RDX are mobile in the soil and, due to this mobility, are a source of groundwater contamination both on and around military sites. Remediation of water and soil at these sites requires rapid, accurate analysis of field samples at the site and in the surrounding area. Each cleanup site will require monitoring for 10-30 years, necessitating analysis of thousands of samples.<sup>1</sup> Currently, samples are collected and sent to a central laboratory for analysis by RP-HPLC according to U.S. EPA SW846 Method 8330, either by direct injection or after preconcentration using an extraction procedure. Turnaround times vary from a week to a month, with laboratory costs per test ranging from \$1000 to \$250 respectively. Current methods of analysis of both water and soils are insufficient for on-site decision making.

On-site detection systems would reduce costs substantially, provide real-time data, simplify site characterization, and expedite remediation. The estimated cost per test for on-site test analysis would range from \$3-\$38 per test, far below the \$250- \$1000 current costs. For site characterization, extra samples could be tested in areas where explosive residues were first detected so that the exact distribution of pollutants could be confirmed. For remediation, rapid on-site analysis could be used to guide earth moving procedures, indicate immediately the need for replacement of pump and treat

granular activated charcoal (GAC) filters, and monitor progress of composting or other remediation operations. Small composting tests indicate that a substantial decrease in contamination is observed in 30 days. Timely determination of those levels would reduce unnecessary composting times. Overall, on-site analysis would eliminate time delays, leading to more effective use of manpower and equipment. Though commercial immunoassay test kits have been introduced to field testing (D-Tech, Ohmicron), they require timed reagent addition, involve multiple steps, and are not easily adapted to online monitoring requirements. Colorimetric methods, also commercially available (EnSys), have these same limitations and require large quantities of solvents and disposable materials. The NRL environmental immunosensors, fiber optic biosensor and continuous flow immunosensor (Figures 1 and 2), are able to analyze a sample on-site in less than 10 min at a cost of \$3-4 per test.

## **1.2 Official DoD Requirement Statement(s)**

A 1.1.a Develop Improved Field Analytical Techniques. Priority: M.

N 1.101.k Improved Field Analytical Sensors, Methods, and Protocols to Supplement Traditional Sampling and Laboratory Analysis. Priority: M.

**1.2.2 How Requirement(s) Were Addressed.** The fiber optic biosensor and the continuous flow immunosensor are analytical instruments that can be employed in the field. They are rapid, sensitive systems capable of monitoring TNT and RDX down to low parts per billion (ppb) without preconcentration. This is an improvement over the current U.S. EPA approved method (SW 846 Method 8330) which is performed in an off-site laboratory via high performance liquid chromatography (HPLC). In the HPLC method, preconcentration of the sample is required for explosive levels below 20 ppb. Demonstration of the sensors on-site for the detection of TNT and RDX addressed the requirement for improved field detection techniques.

## **1.3 Objectives of the Demonstration**

The primary objectives of this project are (a) to demonstrate the efficacy of these immunosensors for on-site characterization of areas contaminated with explosives in both water and soil and (b) to gain validation of both methods by U.S. EPA and/or other regulatory agencies.

To meet these objectives, three field trials for groundwater analysis and one for soil were performed using the two biosensors to perform on-site analysis. The first groundwater test for this project was conducted in June 23-27, 1997 at SUBASE Bangor, Bangor, WA. The second site was Umatilla Army Depot (UMDA) in Hermiston, Oregon August 4-8, 1997. The third site was Naval Surface Weapons Center in Crane, Indiana September 8-12, 1997. The soil field trial was held April 27-May 1, 1998 at Manchester Washington on samples from Umatilla Army Depot. Both sensors were operated on-site by non-NRL employees as well as NRL staff. Splits of the field sample were analyzed by the immunosensors and U.S. EPA SW846 Method 8330. In addition to on-site soil analysis, T. Jenkins CRREL provided ten archived soil samples from various sites in the U.S. Method 8330 analysis was performed for the groundwater samples by QST Environmental Laboratories under contract to H. Craig, U.S. EPA Region 10 while the soil samples were analyzed by GP Laboratories and NRL. Results were evaluated on accuracy, precision, rate of false

positives/negatives, cost, time, and waste generation. Samples from other contaminated sites were also analyzed to study groundwater matrix effects. In addition to the contaminated field samples, appropriate controls, blanks and interferents were tested in the lab for certification and validation data requirements.

#### **1.4 Regulatory Issues**

Congress has enacted several legislations regarding the cleanup and monitoring of compounds that pose a potential risk to humans and the environment. Several examples of those legislations that apply to explosive compounds include the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and its amendments (CERCLA, a.k.a. Superfund). The sites employed for these demonstrations are on the Superfund list.

#### **1.5 Previous Testing of the Technology**

ESTCP previously funded the non-automated fiber optic biosensor for demonstration of its ability to detect on-site TNT in groundwater. During that project, the fiber optic biosensor was tested at Umatilla Army Depot in Hermiston Oregon and SUBASE Bangor in Bangor Washington. Results of these field demonstrations were encouraging. Full details of the results can be found in the ESTCP final report Fiber Optic Biosensor and well as in two refereed papers.<sup>2-3</sup> Prototypes of the continuous flow immunosensor also participated in those field demonstrations with funding from SERDP. Results for the continuous flow immunosensor can be found in several refereed papers.<sup>4-6</sup> The EPA coordinator Harry Craig has written a report of the field trials and has a proceedings paper describing both sensors.<sup>1</sup>

## **2. Technology Description**

### **2.1 Description**

#### **2.1.1 Fiber Optic Biosensor**

The fiber optic biosensor uses molecular recognition and evanescent wave sensing to detect a wide variety of analytes.<sup>27-11</sup> The fiber optic sensor consists of a multichannel ‘fluorimeter’, a fiber bundle jumper, and disposable fiber optic probes.<sup>12</sup> Properties of optical fibers provide a mechanism for exciting fluorescent molecules that are very close to the fiber core. Light is totally internally reflected within the optical fiber core. An electromagnetic field is generated around the core with exponentially decreasing power. This field is referred to as the evanescent wave (Figure 3). The effective or penetration depth of this field is determined by the wavelength of light and the refractive indices of the fiber core and the surrounding media. In the case of the fiber optic biosensor, the penetration depth is approximately 125 nm. Fluorescent molecules that enter the evanescent wave are excited and emit light at a longer wavelength, i.e., fluorescence. Effectively, these fluorescent molecules are ones that bind to the surface, i.e., antibody-fluorescent antigen complexes. A portion of this fluorescence is captured by the fiber and transmitted to a detector. Molecules outside the evanescent wave are

not detected by the sensor, thereby eliminating wash steps. In this biosensor, the optical fiber probes are tapered to provide maximum excitation and fluorescent emission recovery.

The multichannel “fluorimeter” Analyte 2000, produced by Research International in collaboration with NRL (Figure 1), consists of four integrated circuit ‘daughter’ cards (Figure 4) that are monitored by a microprocessor-based controller board.<sup>12</sup> On each ‘daughter’ card is mounted a 5 mW 635 nm diode laser modulated at 135 Hz for synchronous detection. An internal transfer fiber transmits the laser light to the excitation leg of the bundle jumper. A second internal fiber transmits the fluorescent emission from the bundle jumper to a photodiode which is also mounted on the ‘daughter’ card. Appropriate filters and signal calibration controls are also incorporated on each ‘daughter’ card. The controller board monitors each card and sends the measured signal from each channel to a laptop computer through an RS-232 communication port. The computer software collects, plots, stores data, and permits user control over several other functions.

The fiber bundle jumper transmits the excitation light from the “fluorimeter” to the fiber optic probe and the returning fluorescent signal to the device. The jumper consists of a fiber in the center to provide excitation and larger surrounding fibers to collect the fluorescence emission from the sensor probe. The fiber optic probe provides the sensing region for the biosensor. Each optical probe is made from 600  $\mu\text{m}$  fused silica multimode fibers with a connector on one end. The end of the probe has the cladding removed to permit attachment of the recognition molecule directly onto the fiber core. This sensing region is tapered to provide efficient fluorescence excitation and signal collection.<sup>13</sup> After the recognition molecule is immobilized, the coated probe is inserted into a sample chamber. This sample chamber may be formed from a 100  $\mu\text{l}$  capillary tube with plastic tees on each end (Figure 5).<sup>8</sup> The capillary chamber system can be injected with syringes or peristaltic pumps for system automation. A semi-automated fluidics system developed at NRL, which employs a mini peristaltic pump, was used for this study.

The disposable fiber optic probes provide the region for specific detection. Antibodies, immobilized on the surface of an optical fiber, provide molecular recognition. Degree of specificity is determined by the choice of the antibody employed. Two types of immunoassays have been used with this sensor. In both scenarios, antibodies are immobilized on the fiber surface. For smaller molecules such as TNT and RDX, a competitive fluoroimmunoassay is performed. In this assay, a fluorescently-labeled antigen analog competes with the antigen for antibody binding sites. A decrease in the maximum fluorescent signal is observed that is proportional to the antigen concentration. For the larger compounds, sandwich immunoassays are performed. The antibody-coated fiber probe is exposed to the antigen containing sample, then to a second antibody that is fluorescently labeled. An increase in the fluorescent signal proportional to the concentration of the antigen is observed. Assays have been developed for small molecules (TNT), proteins (F1 protein of *Yersinia pestis*), toxins (ricin and botulinum), and whole bacterial cells (*Bacillus anthracis*).<sup>2,7-11</sup>

In the assay for the explosive TNT or RDX (purpose of this study), the antibody-coated fibers are first exposed to a solution containing buffer plus a known concentration of a fluorescently-

labeled analog of TNT or RDX. After five minutes of exposure to this fluorescent solution, the laser light is turned on for a reading. Only fluorescently-labeled analog bound to the fiber generates a signal. This is the maximum signal generated and is referred to as the reference or 100% signal. To remove the bound analog from the antibody-coated fiber optic probe, a solution of 50% ethanol in buffer is injected over the fiber for 10 minutes and then a fluorescent reading is taken. Next, the fiber is immersed in buffer for 1 minute to prepare it for the next sample. A background reading is taken again. After an assay with the fluorescently-labeled analog alone, an unknown or standard can be assayed. To the unknown or standard sample, fluorescently-labeled analog is added to make the sample contain the same concentration as that used for the 100% signal. An acetone soil extraction is performed to get a liquid sample needed for analysis. The unknown or standard solution with the fluorescent compound is exposed to the fiber for five minutes. The laser light is turned on and the fluorescent signal determined. If TNT or RDX is present, the fluorescent signal for the unknown will be lower than the reference or 100% signal. This decrease in the signal is proportional to the amount of TNT or RDX in the sample and represents competition between the fluorescently-labeled analog and the explosive for the limited number of antibody sites on the fiber probe. The fiber is then regenerated to remove the bound material by exposure to the 50% ethanol solution for 10 minutes followed by one minute with buffer. The fiber is then ready for the next reference sample. The reference sample is run before and after each test sample to monitor continuously for any variation in antibody activity. A representative graph demonstrating multiple assays is shown in Figure 6.

The fiber optic biosensor system is rapid (<17 min), reliable, portable, and highly sensitive (low ppb), and can be used to detect substances in real-world samples such as river water, groundwater and bilge water. We have demonstrated successful analyses in opaque, viscous samples with a portable fiber optic sensor. This portable sensor is also capable of detecting four test samples simultaneously.

### **2.1.2 Continuous Flow Immunosensor**

The Continuous Flow Immunosensor is based on a displacement assay that utilizes antibodies specific for the analyte of interest as a means of detection. The key elements of the sensor are: 1) antibodies specific for the analyte, 2) signal molecules which are similar to the analyte but labeled with a fluorophore (usually a Cy5 dye) so they are highly visible to a fluorescence detector, and 3) a fluorescence detector. For an analysis, the antibodies which specifically recognize the contaminants are immobilized on a solid support and the fluorescently labeled signal molecule is bound to them, creating an antibody/signal molecule complex. The functionalized support is placed in the sensor and connected to a water stream. A sample is then introduced to the system through the injection port. As with the fiber optic biosensor, an acetone soil extraction is performed to obtain a soil sample. If the sample contains the target analyte, a proportional number of labeled signal molecules is displaced from the antibody and detected by the fluorimeter downstream. Figure 7 shows a schematic of the immunosensor operation.

Displacement assays, using the laboratory version of the Continuous Flow Immunosensor, have been developed for a wide range of small molecular weight compounds, including drugs,

explosives, and pesticides.<sup>4-6,14-16</sup> Existing assays for a number of environmentally relevant explosives include TNT, RDX and DNT.

The manufacturable, field-portable version of the biosensor, the FAST 2000, has been engineered by Research International (Figure 2). The FAST 2000 is a rapid and convenient system for performing displacement assays with a resolution to 5 ppb for groundwater and 50 ppb for soil. The optically-based signal gathering capabilities are combined with precise fluidics control in a PCMCIA-based PC application. The unit can be easily carried into the field and plugged directly into a portable PC for on-site data acquisition and analysis. Analysis time for each sample is approximately 2 minutes.

The system is controlled by an advanced Windows-based software program. The hardware is designed to use a National Instruments data acquisition card (DAQCard - 1200) for gathering data from the FAST 2000 control unit. An outboard box provides convenient storage of the various fluids required to perform the assays.

The system has been developed as a complete turnkey unit. The software provides a simple menu driven interactive user interface to lead users through the steps required to successfully determine if a trace amount of analyte is present in a given sample. The software also allows the more advanced user complete control of the operational parameters for running nonstandard procedures. The hardware provides the necessary fluid storage and flow control, including providing an automated reference standard assay that can be used anytime to calibrate the system. The assays are run in disposable coupons using a robust affinity membrane to perform the displacement assay protocol.

Data analysis is made easy with the use of real time plotting of the data, data logging, and custom calibrations. The Windows-based software allows for both ease of use and complex system manipulation, keeping all skill levels in mind. The assay chemistry for TNT and RDX detection has been developed to be a functional and robust system that can be successfully used in the field without the need for excessive environmental controls.

The FAST 2000 requires a computer capable of running Windows 95 or Windows 3.1 in enhanced mode. Under Windows 95, the minimum configuration is 12 MB of RAM and a 486/80 MHZ PC, while under Windows 3.1, the minimum configuration is a 486/DX 33 MHZ PC with 12 MB of RAM. In this minimum configuration, the FAST 2000 system should be the only program running. A mouse is highly recommended since not all program features are available without one. An outboard box, connected to the FAST 2000 unit via color-coded tubing, contains the waste bottle, buffer bag and reference standard bag. Before beginning an assay, flow buffer (10 mM sodium monophosphate, 2.5% ethanol and 0.01% Tween) is pumped into a buffer bag and the system is pressurized with air to control the fluid flow.

The FAST 2000 system utilizes a disposable coupon for performing the assays. The coupon contains discrete flow channels, a membrane and filter pocket in a removable plug, pneumatically controlled valves, and septum seal area used for injecting fluids into the coupon. The coupons are assembled with the functionalized membranes before shipping. Prior to

instrument operation, the coupon is inserted into the FAST 2000 control unit, and when the handle is engaged, the coupon septum is automatically pierced. Through the Task Manager in the system software, assays are performed by a sequence of valve controls which meter the assay fluids through the coupon and into the membrane pocket. The fluids then exit the coupon and travel into the integral fluorimeter in the control unit which detects any fluorescence signal present. Quantitation of the analytes, done by the system software, compares fluorescence intensity to that of a reference standard.

The system is equipped with the capabilities of performing a reference assay to be used as a standard for calibrating each membrane. This is referred to as the reference standard assay. The fluid is stored in a 3 mL bag in the outboard box. When 'Run a reference standard assay' is selected from the software Task Manager, the control program automatically injects fluid from the reference standard bag and performs an assay. The calculated area under the signal peak can then be used to calibrate further assay runs. Also, the reference standard assay can be used to predict the life of the membrane. Membranes that need to be replaced will have significantly reduced signal peaks.

Another method of introducing samples is to inject into the coupon through the small septum area on the top of the coupon. This reduces the sample volume required to perform an assay to 0.15 mL. Through the Task Manager, the user is instructed when to inject the sample into the coupon. Injection is done by inserting the needle of the small volume syringe through the tape cover and into the septum seal.

The coupon and membrane can be used for repeated assays. The life of the membrane is dependent upon the number of positive assays that were run. Since only a limited quantity of the label is bound to the antibodies on the membrane, it will eventually become depleted of the label. This may take one to three days, dependent upon usage. If the standard sample cannot be detected, the membrane must be replaced.

## **2.2 Strengths, Advantages, and Weaknesses**

The fiber optic biosensor and the continuous flow immunosensor are rapid analytical tools for the on-site detection and monitoring of compounds. Little sample volume or manipulation is required for groundwater detection. An extraction needs to be performed for soil analysis. The biosensors are completely portable (battery operated and lightweight), which is preferable for on-site analysis. Full set-up (from shipping box to sample analysis) takes approximately 1 hour.

The major strength of the NRL sensors is their adaptability for use in a variety of environments. The biosensors have been tested directly in a variety of environmental media including ground and river water, leachate, and soil extracts that may or may not contain particulates with little or no effect on the overall activity of the sensors. Samples can be injected by hand or pump from air samplers that extract vapors into water, or soil extractions. In addition, super sipper systems that rapidly inject samples from hundreds of vials can be employed.

The fiber optic biosensor is capable of analyzing a single sample run either in quadruplicate over four similar fibers or four fibers with different antibodies simultaneously. This advantage

provides the ability to have assay controls performed during sample analysis. In the case of TNT, the fiber probes have been 'regenerated' and reused up to 16 test samples. The continuous flow immunosensor can be used either for continuous monitoring of a water stream, or for testing multiple discrete samples sequentially for an extended period of time per antibody cartridge. The number of samples tested is based in part on the number of positives, since negative samples do not deplete the labeled antigen from the cartridge. For TNT and RDX, more than 50 positives can be analyzed over a single column/cartridge.

The detection limit of the instruments is already comparable to established, more complicated systems. Using the NRL sensors, TNT in water has been detected at levels of less than 5 parts per billion (equivalent to 5 ng/mL) in the laboratory. This level of sensitivity is well-below that obtained using precipitation, dip stick, most enzyme immunoassays, and fluorescence polarization methods, and is comparable to radioimmunoassays. The limit of detection for field groundwater samples is slightly higher (5-10 ppb) and 50-100 ppb for soils.

Antibodies are recognized by biochemists and molecular biologists for their exquisite specificities. Antibody selection is based on affinity and specificity for the compound of interest. Antibodies can be selected such that the specificity is a narrow range for just one compound or wider for a group of similar compounds. Closely related compounds may also react with the antibody but usually with a lower affinity. Molecules such as TNT and RDX are too small to be antigenic so they or a closely related analog is coupled to a larger protein for antibody production. A larger protein cannot be coupled directly to TNT so the compound trinitrobenzene (TNB) was linked to a protein and used as the antigen to elicit antibody production. The TNT antibody used with the fiber optic biosensor, obtained from Strategic Diagnostics, Inc. (Newark, DE), was produced against a TNB conjugate and selected for its affinity for TNT. Therefore, this antibody reacts with both TNT and TNB. The same is true for the 11B3 anti-TNT antibody employed in the continuous flow immunosensor.<sup>14</sup> This poses a problem if one needs know the exact concentration of TNT in the presence of TNB. The result would be an overestimation of TNT in the sample. However, since both TNT and its degradation product TNB are both toxic and explosive, this cross-reactivity is not necessarily a detriment with a screening system as both require cleanup/remediation. The RDX antibody used with both sensors, obtained from Strategic Diagnostics, Inc., has also been selected for its strong affinity and low cross-reactivity with other compounds. The extent of its cross-reactivities is detailed in the company brochure but does include HMX.

One problem with any antibody-based assay is that the compound of interest must be known prior to analysis so that the appropriate antibody can be employed. Unlike HPLC which identifies a large number of compounds, an antibody recognizes only a single or limited number of structurally similar compounds. On the other hand, most samples contain both toxic and non-toxic components. In HPLC, both types will be identified with swamping of the toxic compound signal by that of the non-toxic compounds a possibility unless a laborious extraction procedure is followed. This problem can be eliminated using antibody-based assays because only the toxic compound generates an antibody-mediated signal.

### **2.3 Fiber Optic Biosensor and Continuous Flow Immunosensor Comparison**

The fiber optic biosensor and the continuous flow immunosensor are both technologies that rely on antibody-antigen interaction, with fluorescence used for signal transduction. However, they are complementary rather than competing methods, with applications in distinctly different areas. Table 1 summarizes the differences and similarities discussed in previous sections. Specifically, the FOB is more suitable for testing environments requiring remote detection (i.e., soil or groundwater monitoring with a cone penetrometer). In contrast, the continuous flow immunosensor is more appropriate and cost effective in test scenarios that require routine on-site measurements of either discrete samples or intermittent monitoring of process streams (pump-and-treat filters, quarterly tests of monitoring wells). In either case, both sensors are rapid compared to current technologies and are easy to set up and operate in the field. The choice of which sensor to employ must be decided by remediation managers on a case-by-case basis.

### **2.4 Factors Influencing Cost and Performance**

The NRL immunosensors are designed to be user-friendly for people with medium skill levels. Many of the parameters that may affect cost and performance have been identified. Some of the high cost associated with the instruments and the antibody-coated substrates are due to the fact that they are prototypes and not in production. The cost should decrease with increased commercialization of the instruments. Another cost is the requirement for sample pre-treatment (other than soil acetone extraction) or concentration, though this is indirectly related to the technology. The biosensors have been designed for a certain level of detection. This does not preclude the use of pre-concentration or filtering methods to improve the limit of detection. This study did not use any pre-concentration or excessive filtering for any of the samples. By adding in a pre-treatment step, cost will increase due to increase in labor time and the reduction in the number of analyzes that can be achieved per day. Both instruments require minimal labor time for set-up of the instruments. Currently, there is some variability in the length of time needed to wash the FAST 2000 membranes prior to initial sample analysis which is being addressed.

In summary; factors affecting costs include:

- Cost of manufactured instruments (prototypes vs. production)
- Labor costs associated with fully-automated FAST 2000 system
- Disposable components (fiber optic probes, FAST 2000 coupon, membranes)
- Commercialization of antibody-coated membranes and fluorescent-analog
- Commercialization of antibody-coated fiber optic probes and fluorescent analog
- Sample pre-treatment (filtering or pre-concentration), if necessary
- Washing time for FAST 2000 membranes for initial analysis
- Number of analyzes per day
- Maintenance of NRL fluidics (little is needed for Analyte 2000)
- Maintenance of FAST 2000
- Sample Characteristics (i.e., high/low concentration, interferent level)

### 3. Site/Facility Description

#### 3.1 Background

Site selection was based on several criteria including contamination with explosives, accessibility to the site and the groundwater, U.S. EPA interest (i.e., Superfund), availability of non-NRL personnel and a variety in geological parameters. Samples from five sites in the continental United States have been analyzed with the biosensors. Two of the on-site facilities (SUBASE Bangor and Umatilla) are currently undergoing extensive remediation for groundwater contamination with TNT and RDX using pump-and-treat technology. As a result, these sites provided a number of platforms for effective testing of the sensors, including a) direct measurement of contamination levels in monitoring wells, b) analysis of samples in the treatment system (pre- and post-GAC filtration), c) direct comparisons with current field and lab measurements using the ENSYS test kit and SW 846 Method 8330, respectively, and d) experienced Army Corps of Engineers personnel familiar with the site. The EPA Region 10 military site coordinator (two of the sites are in Region 10) provided non-developer personnel to run tests, in compliance with the validation guidelines, as well as assisted in obtaining necessary logistical support.

**3.1.1 Naval Submarine Base, Bangor Washington (Groundwater).** Naval Submarine Base (SUBASE) Bangor is located northwest of Seattle, Washington and is currently the home port for Trident submarines. From 1942 to 1973, SUBASE Bangor was used as an ammunition depot. Two sites (Site A and Site F) on the base have been inactivated due to explosive contamination. Wastewater from ordnance demilitarization was disposed into an unlined lagoon. This site is referred to as Site F. Currently this site is undergoing cleanup via a pump-and-treat method through granular activated charcoal filters. Sediment that accumulated at Site F was transported to Site A for burning and disposal in a lined area. Water is flushed through the contaminated soil, collected as leachate and processed through a granular activated charcoal (GAC) unit. The four major contaminants identified are TNT, TNB, RDX, and HMX, ranging in concentration from 0-10,000 µg/L.

**3.1.2 U.S. Army Ammunition Depot, Umatilla Oregon (Groundwater and Soil).** UMDA is located in eastern Oregon and is slated for closure. The base was established as an Army ordnance depot in 1941. From the 1950's until the mid-1960's, UMDA operated an explosive washout facility to remove and recover explosives from munitions. The standard and accepted procedure at that time was to flush and drain the washout system into two unlined infiltration basins or lagoons. A 45-acre plume of RDX in the shallow groundwater aquifer near the lagoons was identified in 1981. Further investigation documented the presence of explosives in both soil and groundwater, ranging in concentration from 0-10,000 µg/L in the groundwater aquifer. These explosives included TNT, TNB, RDX, and HMX. Bioremediation of the soils from the lagoons is currently underway. Treatment of the groundwater consists of pump-and-treat through granular activated charcoal filters, with re-injection of the polished water back into the aquifer.

**3.1.3 Naval Surface Weapons Center, Crane Indiana (Groundwater).** In late 1941, Burns City Naval Ammunition Depot (later renamed Naval Ammunition Depot Crane - NAD Crane) was established. The overall mission was to load, prepare, renovate, receive, store and issue ammunition to the fleet. Over the next few years, NAD Crane's role increased to include pyrotechnics production, mine filling, rocket assembly, torpedo storage, ordnance spare parts, and mobile equipment storage. NAD Crane supplied ammunition during the Korean and Vietnam conflicts to the fleet. In 1976, the mission and name were changed. The new Naval Weapons Support Center Crane was to provide support for ships equipment, shipboard weapon systems, and assigned ordnance items as well as provide support for the Crane Army Ammunition Activity which includes production and renovation of ammunition, storage, demilitarization and disposal of conventional ammunition. In 1992, the site was designated NAVSURFWARCENDIV.

Contamination at Crane, located at three sites: a) Ammunition Burning Ground (ABG) b) Rockeye and c) Rifle Range, is primarily due to the demilitarization and disposal of ammunition and pyrotechnics. Contamination of the groundwater with TNT and RDX exists along with high levels of trichloroethylene (TCE). The method for disposal is based on the physical and chemical characteristics of the munition with double open burning or flashing being the most common. Since the 1940's, ABG has been used extensively for destruction of explosive contaminated material. Between 1956 and 1960, 15,000 pounds/day of smokeless powder and 48,000 pounds/day of high explosives were burned. Initially, solid explosive residues were spread out on burning pads or in flash pits and ignited. Today, clay-lined steel pans are employed. For the liquid explosive contaminated material three surface ponds were employed to remove the liquid from combustible sludge. In 1982, the ponds were modified to include a liner and leachate collection system. Currently, sludge burn pads are used and the ponds closed. Leachate and runoff were initially stored in two underground tanks. Now pink water is stored in two aboveground tanks and the underground tanks are closed. Demilitarization continues with more stringent requirements to prevent soil and water contamination.

## **3.2 Site/Facility Characteristics**

**3.2.1 Naval Submarine Base, Bangor Washington.** SUBASE Bangor, northwest of Seattle Washington, is located in a region with wet climates. The hydrology of the soils is fluvial/glacial deposition and contains high levels of organic compounds. The groundwater from the contaminated region is pumped to a facility containing several GAC units. Approximately 600 gallons of water per minute is treated with this system. The groundwater is known to be high in organic material and highly turbid.

Figures 8-11 contain the maps of SUBASE Bangor and the contaminated sites that were used for this field trial. Figure 8 is the entire base showing site locations for restoration. Sites A and F are highlighted. Site F was used for demilitarization and is the area where the unlined lagoons contained the wastewater. Figure 9 shows the historical features of Site F. The groundwater from this area is undergoing remediation through GAC units. Figure 10 shows

the extent of contamination and cleanup for Site F. The water treatment facility is identified on this figure. Groundwater from the monitoring wells and before/after the GAC units was analyzed. Site A is being used for cleanup of contaminated soils. The soil is placed in a lined basin and the leachate is collected and remediated through GAC units. Figure 11 gives a schematic of this site. The water coming into and out of the GAC in Site F was tested with the biosensors.

### **3.2.2 U.S. Army Ammunition Depot, Umatilla Oregon.**

UMDA is located due east of Portland, Oregon and near the Columbia River in an arid region with no surface water. The primary geology is alluvium on top of basalt, with approximately 100 feet to groundwater. The groundwater flow is northeast to southeast, depending upon the irrigation pumping season. The net flow to the southeast has led to the spread of explosive contamination. The groundwater from the contaminated region is pumped to a facility containing several GAC units. Approximately 600 gallons of water per minute is treated with this system. Figure 12 provides a map of UMDA and the contaminated sites that were used for this field trial. The locations for restoration are shown and each groundwater monitoring well is identified by number. The site of the former munitions cleanout plant, now demolished, is marked "A". The extent of contamination (approximately 45 acres) is shown by the concentric circles.

### **3.2.3 Naval Surface Weapons Center, Crane Indiana.**

NAVSURFWARCENDIV is located in the eastern Illinois Basin. Crane consists of undulating terrain with many small drainageways. Four types of soil are identified at Crane including Wellston-Gilpin, Wellston-Berks-Gilpin, Wellston-Berks-Ebal and Wakeland-Wilbur-Haymond. These soils are primarily silt loams with 0.6 to 2.0 in/hr permeabilities. The bedrock at Crane is lower Pennsylvanian and upper Mississippian age sandstones, limestones and shales. Surface drainage from the facility flows to the south, eventually emptying into the east fork of the White River.

ABG is approximately 20 acres near the east center boundary of NAVSURFWARCENDIV. (Figure 13) It lies in Little Sulphur Creek Valley. Surface drainage flows into and from the ABG via Little Sulphur Creek with the flow varying considerably with the seasons. Downstream from the center of ABG, surface flow ceases during the dry months as the water is captured by vertical infiltration into the sandstone and limestone aquifer underlying the area. Within ABG, there are designated areas for different methods of demilitarization including burn pads, burn pans, pink water tanks, incendiary cages and a primer pit. All current devices employed are equipped with run-on and run-off controls in the form of lids for pans or drains with sumps. Previous methods of demilitarization contributed to the soil and groundwater contamination.

## 4. Demonstration Approach

### 4.1 Performance Objectives

The objectives of the field trials were the demonstration of the biosensors being operated on-site by non-NRL personnel as well as NRL staff and the generation of analytical data appropriate for sensor validation and certification by a regulatory agency such as the U.S. EPA or Cal EPA. A minimum of four instruments of each biosensor type was employed for each field trial. At least two of the sensors were operated by non-NRL personnel (a U.S. EPA chemist and/or contractor).

A specific goal for the NRL environmental immunosensors was to achieve 1-5 ppb sensitivity for TNT and RDX in environmental groundwater samples and 50-100 ppb in soil samples. Specificity of the sensors was provided by the antibodies immobilized on solid matrices within the biosensors. The immunosensors should be specific for TNT and RDX with minimum cross-reactivities. It should be noted that cross-reactivity with TNB and HMX are expected with the antibodies employed. Accuracy and precision were evaluated using linear regression and relative percent differences (RPD). It has been noted in several papers that  $\pm 50\%$  RPD is routinely used as the control limit.<sup>18,19</sup> Our goal for the linear regressions was a correlation coefficient of 0.70. In addition to sensitivity and specificity, other advantages of the sensors including low generation of waste, short analysis times, limited sample preparation, low cost per analysis, and little or no matrix effects were validated.

### 4.2 Physical Setup and Operation

**4.2.1 SUBASE Bangor (Groundwater and Umatilla soils).** At this site, the biosensors were set up in one room in a one story office/conference building attached to the Manchester EPA laboratories in Manchester, WA. The building housed two offices (unoccupied at the time) and two conference rooms. Both the flow biosensor and the fiber optic biosensor were deployed and operated in the larger conference room at the front of the building. The building was temperature controlled and electricity was available. The building had a single sink, but no refrigerator. Samples were stored in a walk-in refrigerator in the main EPA laboratory building and carried to the conference building in coolers as needed. All preparation of the samples was performed in the room with the instrumentation. All materials necessary for the analysis of groundwater were carried with us on-site. Setup of the four flow immunosensors took approximately 30 minutes. The antibody-coated membranes need to be washed prior to initial sample analysis to obtain a sample baseline. The four fiber optic biosensors were operational in less than one hour. The EPA laboratories' water deionizer supplied water as was needed.

**4.2.2 Umatilla Army Depot (Groundwater).** At the UMDA field test site, the biosensors were operated in one room in a one story office/conference building located inside the military installation. The building housed two offices (1 occupied at the time), one utility room (refrigerator) and one conference room. Both the flow biosensor and the fiber optic biosensor were deployed and operated in the conference room toward the rear of the building. The building was temperature controlled and electricity was available. The utility room contained

a refrigerator for storage of samples, a sink, and table for sample preparation. Samples were stored in the refrigerator until diluted for immunosensor analysis. All preparation of the samples was performed in the room with the instrumentation. All materials necessary for the analysis of groundwater were carried with us on-site. Setup of the four flow biosensors took approximately 30 minutes. The antibody-coated membranes need to be washed prior to initial sample analysis to obtain a sample baseline. The four fiber optic biosensors were operational in less than one hour. Distilled water was obtained for sample dilution as was needed.

**4.2.3 Naval Surface Weapons Center Crane (Groundwater).** At this location, the biosensors were set up in two rooms in a two-story building. The building housed a library in the basement and the upper floor was undergoing renovation. A finished conference room was employed for four semi-automated fiber optic biosensors. Four Continuous Flow Immunosensors were setup in a large unfinished area. The building was temperature controlled and electricity was available. A small sink and refrigerator were available for preparing and storing samples. Everything needed to perform groundwater analysis was brought with us. Setup of four FAST 2000 instruments took approximately 30 minutes. The antibody-coated membranes need to be washed prior to initial sample analysis to obtain a sample baseline. The four fiber optic biosensors were operational in less than one hour. As with the other sites, distilled water was purchased from a local grocery store.

## **4.3 Sampling Procedures.**

**4.3.1 Groundwater.** Groundwater from monitoring and extraction wells in contaminated areas were collected by on-site personnel or EPA Region's contractor for analysis. In addition, spring water was also collected at the Crane site. Groundwater from the monitoring wells and before and after the GAC units were analyzed at all three sites. Samples were initially collected into 20L EPA-approved cleaned containers and sealed until on-site analysis or shipment to laboratories for analysis. Individual groundwater samples were collected directly from the extraction wells. In addition, groundwater samples were collected from the combined flow from the extraction wells at sampling ports before and after initial particulate filters and upstream of the granular activated carbon (GAC) unit at SUBASE Bangor. After the samples were collected, they were stored in the dark and kept cool ( $<10^{\circ}\text{C}$ ). Aliquots or splits from the large sample container were used for laboratory and field analysis. These aliquots (one liter for each laboratory and 40 mLs for on-site analysis by the biosensors) were stored in EPA-approved cleaned amber bottles in the dark and cool ( $4^{\circ}\text{C}$ ). Due to rapid TNT degradation in groundwater, analysis for TNT was performed within one month of collection. The contract laboratories were monitored by Harry Craig of U.S. EPA Region 10 (QST, Gainesville FL) and P. Gauger of Geo-Centers, Inc. (GP Laboratories).

**4.3.2 Soil.** Soils from Umatilla Army Depot were provided by H. Craig (U.S. EPA) and Gannett Fleming staff. Additional soil samples were provided by T. Jenkins (CRREL). The additional soil samples were from Ft. Ord, CA (1), Hawthorne Army Ammunition Plant, Hawthorne, NV (3), Raritan Arsenal, NJ (1), and Nebraska Ordnance Plant, Mead,

NE (4). They were archived samples that were dry, well homogenized, and fully characterized.

#### 4.4 Analytical Procedures.

**4.4.1 Soil Extraction.** An acetone extraction was performed on all soil samples using the method developed by Jenkins et. al.<sup>20</sup> For the on-site field trial, 20 gm of soil was mixed with 100 mL acetone. The sample was shaken for three minutes and then filtered. The acetone extract was measured. The extract was stored in amber containers at 4°C until analysis. Since there was less than 5 gms of the archived soils, the procedure was modified to 2 gm of soil and 10 mL acetone.

**4.4.2 Fiber Optic Biosensor.** Detection of TNT and RDX was achieved by performing competitive fluorescence immunoassays on the surface of an antibody-coated fiber probe.<sup>2,9</sup> The procedure for making the antibody-coated optical probes has been described in the literature.<sup>17</sup> Briefly, a 10-cm long, 600  $\mu$ m optical fiber probe, with a bayonet connector on one end, has cladding removed from the last 7 cm to expose the core. The probe is tapered in hydrofluoric acid to obtain the optimal geometry for excitation and emission collection. A thiol-terminal silane is attached to the core surface, followed by a heterobifunctional crosslinker. After attachment of the crosslinker, a succinimide residue binds primary amines on the antibody. The antibody-coated fibers can be stored for more than 1 year before use. The preferred method for storage is lyophilized or in buffer at 4°C, but can be stored for extended periods at 25°C.

In a competitive fluoroimmunoassay like the one for TNT and RDX, fluorescent compounds compete with the unlabeled compound in the sample for the limited number of antibody binding sites. The maximum fluorescent signal occurs when there is only the fluorescently-labeled compound present. Fluorescently-labeled TNB (Cy5-EDA-TNB) was used as the competitor in this TNT assay and fluorescently-labeled RDX hapten (Cy5-EDA-RDH) for RDX.<sup>17</sup> As the unlabeled compound increases, a proportional decrease in the fluorescent signal is observed. Using a standard curve generated by evaluating known concentrations of unlabeled compound on the biosensor, unknowns can be assayed and the results compared to the standard curve to determine the concentrations in the test sample.

In the TNT assays run during the field trials, all test solutions, reference solutions and controls contained buffer with the following components: 7.5  $\mu$ g/L Cy5-EDA-TNB in 1x PBS pH 7.4, 5% acetone, 2 mg/mL bovine serum albumin and 0.1% Tween 20. A 10x stock solution of this buffer was used to make all test solutions. After a background reading from PBS buffer, a solution containing only the Cy5-EDA-TNB (reference solution) was exposed to an antibody-coated optical fiber probe for five minutes. Upon laser excitation of the fiber probe, a specific signal that corresponded to the maximum (100%) or reference signal was generated. This reference signal is defined as the signal change associated with the labeled TNB alone. The fiber probe was washed with 50% ethanol in buffer for five minute to remove the Cy5-EDA-TNB. In the case of explosives, the explosive and the labeled analog are more soluble in the

ethanol solution than the buffer. This fact along with the moderate affinity of the antibody permit removal of the material bound to the fiber probe. Next, the probe was re-equilibrated with the PBS buffer solution for two minutes to prepare it for the next sample. At the end of a minute, another background reading is taken.

An unknown or standard is then assayed in a protocol identical to the reference solution. To the unknown or standard, fluorescently-labeled TNB is added to make the sample contain the same concentration as that used for the 100% signal (7.5 µg/L Cy5-EDA-TNB). For water studies, the groundwater replaces deionized water in preparation of the sample. For soils, the acetone extract is employed to achieve the 5% acetone component of the sample, thereby creating a 1:20 dilution. Additional dilutions of the acetone extract may be required to obtain a reading that falls on the standard curve. The fluorescent signal for the test sample will be lower than the reference signal if TNT is present. After the test sample, the fiber probe was regenerated and re-equilibrated with PBS buffer. The protocol for analysis was a reference assay (Cy5-EDA-TNB only), regeneration of the fiber, test sample assay, regeneration, and then another reference assay. If multiple test samples were being assayed consecutively, only a single reference assay is run between test assays. Figure 6 graphically demonstrates this protocol with TNT spiked samples.

The RDX competitive immunoassays followed the same procedure with the following exceptions. First, Cy5-EDA-RDH is employed in place of Cy5-EDA-TNB but at the same concentration. The second exception is the length of time for regeneration. The fiber optic probe is exposed to the 50% ethanol solution for ten minutes instead of the five minutes needed for TNT. This is due to the relative affinity of the anti-RDX antibody compared to the anti-TNT antibody.

Inhibition of the reference signal was observed when TNT or RDX was present in the test sample. The percent inhibition observed was proportional to the explosive concentration in the sample. The reference signal value was determined both before and after the test sample assay in order to normalize for the gradual decrease in the antibody activity. The following equation was used to determine the percent inhibition of the 100% signal value by TNT or RDX.

$$\% \text{ Inhibition} = \left[ 1 - \frac{\text{Test signal}}{\left( \frac{\text{Reference}_{pre} + \text{Reference}_{post}}{2} \right)} \right] * 100$$

By employing the standard curve, the unknown samples could be converted from percent inhibition to µg/L (ppb). The % inhibition and concentration values were determined for each analysis and there was a minimum of seven fiber probes analyzes per test sample.

**4.4.3 Continuous Flow Immunosensor.** The continuous flow immunosensor is based on a displacement immunoassay in which the explosive molecules in the sample selectively “displace” a fluorescently labeled signal molecule from an immobilized antibody. This sensor has been described extensively in the literature based on work with the laboratory version<sup>4</sup>. Procedures used in the field trials with the new FAST 2000 instrument were modified from

previously published work to reflect differences from the laboratory sensor operation. Briefly, all assay parameters and commands are controlled using a PCMCIA-based PC software program arranged by function. The 11B3 TNT and Strategic Diagnostics RDX monoclonal antibodies were immobilized onto porous membrane supports and saturated with the fluorescent analog using the detailed protocols outlined in the Demonstration Plans. The membrane was inserted into a disposable coupon, the coupon was placed in the FAST 2000, and the buffer flow was started by a computer command. Once the fluorescence background signal due to unbound CY5 had stabilized (generally 15-20 minutes), the biosensor was ready for sample injection.

For groundwater samples, a small amount of concentrated flow buffer is added prior to injection to buffer the sample. The acetone soil extracts are first dried down, then brought up in flow buffer before injection. Samples of 150 ul were injected using a 1cc tuberculin syringe in the following order:

**Standard Injection (1000 ppb - 100 ppb)**

Sample Injection #1

Sample Injection #2

Sample Injection #3

**Standard Injection (close to range of the sample)**

Sample Injection #4

Sample Injection #5

**Standard Injection (close to range of the sample)**

Sample Injection #6

Sample Injection #7

**Standard Injection (close to range of the sample)**

This injection protocol proved to be close to ideal when dealing with the displacement assay, where fluorescence peak area decreases both with subsequent samples and with time. By comparing standard injections at the beginning of the sample run with standard injections in the middle and end of the run, we were able to monitor membrane behavior and change the membrane before the accuracy of the analyses was compromised. Also, standards could be selected that closely matched the concentration of the sample. This calibration method improves as working experience with the instrument increases, but even the non-developer users at the field trials very quickly understood how the instrument was behaving and could select standards that closely matched the samples.

For all samples, the computer calculated a Peak Area (integral) that corresponded to the beginning and end of the peak, as defined by the operator. To calculate a sample concentration, the peak area value for each sample was compared to the calibration standards injected before the sample. In most cases, all that was needed was to derive the average area under the peak for all standards of the same concentration. Ideally, the standards concentrations were close in value to signals obtained from the samples being analyzed. This value was then used to derive a concentration/unit signal value (ng/mL/Peak Area Unit [PAU]). The averaged value was applied to each PA from each sample injection to acquire a

concentration for that injection of the sample. The concentrations were averaged and the Standard Deviation (SD) was calculated. In some cases, outlying values were rejected using the Q-Test with a 95% confidence rejection criterion.

**4.4.4 SW-846 Method 8330.** The EPA-approved method for explosive analysis in groundwater is SW-846 Method 8330. This method employs high performance liquid chromatography (HPLC) and a UV detector to determine explosive concentrations. A copy of SW-846 Method 8330 is located in Appendix C. For low concentration water samples (< 20 µg/L), a salting-out extraction is performed, whereas higher concentration water samples are injected directly. All analysis by QST and GP Laboratories on the test water sample splits and standards employed the salting-out extraction step prior to analysis. In addition to the contract laboratories, NRL performed direct injection analyses of all samples. For soil extracts, the acetone extract (10-100 µl) is dried down. Next, 1-2 mls of 50/50 methanol/water is added and this is used for direct injection. The columns for HPLC analysis are a C-18 reverse phase followed by a CN reverse phase column. The mobile phase is 50/50 (v/v) methanol/sample or methanol/water. The absorbance is monitored at 254 nm. The explosive concentrations for Method 8330 are based on a single analysis, unlike the multiple analyzes performed by both biosensors. Since Method 8330 is the “standard”, HPLC results from QST and NRL were evaluated to assess the accuracy and precision (Figure 14).

## **5. Performance Assessment**

### **5.1 Performance Data**

There is not one clear-cut way to analyze the correctness of the results of the various assays for the detection of TNT and RDX. Several statistical methods were employed to evaluate the data from the field trials. One method compared the relative percent difference (RPD) between baseline concentration (Method 8330) and the result of the field screening method. At the lower concentrations, minor differences will show up as large RPD's. The second method used linear regression curves of the field screening results versus Method 8330 concentrations. With this method, variations in the higher concentrations have a large effect on the regression line. Examination of both the RPD and linear regression data gives a better overall picture of each assay. The bias and precision of each method was also evaluated for groundwater samples. Spikes of soil samples were not performed due to concern over accurate representation of spiked soil to weather-conditioned soil in regard to extraction efficiency and matrix effects. In addition to the statistical analysis, other factors were examined including false positives/negatives, analysis time, analysis cost, sample size, use of solvents, and operator skill requirements.

As mentioned earlier (2.1.3), the biosensor technologies are based on different principles and should be considered complimentary and not necessarily competitors. Consequently, the analysis of the fiber optic biosensor and the continuous flow immunosensor will be discussed separately. Field demonstration data for both sensors will be compared to Method 8330 for TNT and RDX. Other factors used to evaluate the biosensors will also be examined.

**5.1.1 Relative Percent Difference (RPD).** The RPD values between Method 8330 concentrations and the field screening results were calculated with the following equation

$$RPD = \left( \frac{(D_1 - D_2)}{\left( \frac{D_1 + D_2}{2} \right)} \right) * 100$$

where  $D_1$  = Field Screening concentration and  $D_2$  = Method 8330 concentrations. The smaller the RPD value, the closer are the concentrations of the two methods and the more accurate the field screening method. A positive RPD indicates that the field screening method gave higher concentrations than Method 8330 results. The reverse is true for a negative RPD. A value of  $\pm 50\%$  RPD is acceptable.<sup>18,19</sup>

**5.1.2 Linear Regression.** Linear regression plots were constructed to evaluate the accuracy of the field screening methods. The results from each method were plotted versus the Method 8330 results for each sample. A best-fit line was calculated for each assay method at each field test site. Under ideal conditions, true accuracy would have a slope = 1.0, y-intercept = zero, and a correlation coefficient ( $r^2$ ) = 1.0. A slope greater than 1.0 indicates that the field screening methods generally give higher concentrations than Method 8330, and the reverse is true for slopes less than 1.0. The correlation coefficient indicates the amount of scatter in the data, with 1.0 indicating no scatter.

**5.1.3 Other Statistical Values (Groundwater Only).** Method bias (accuracy) is determined with the following equation:

$$bias = \left( \frac{\bar{X}}{X} \right) * 100$$

where  $\bar{X}$  is the mean value for seven or more replicate determinations and  $X$  is the spiked or characterized concentration. To determine the precision of the biosensor, the standard deviation and the mean are employed as follows:

$$precision = \left( \frac{s}{\bar{X}} \right) * 100$$

The U.S. EPA also requires the Method Detection Limit (MDL) and Reliable Quantitation Limit (RQL).<sup>21</sup> The MDL is calculated based on the low matrix spike standard deviation from the seven replicates:

$$MDL = 3.143 \sigma$$

The RDL is defined as four times the MDL.

#### 5.1.4 Fiber Optic Biosensor

Raw data from the field demonstrations and the laboratory analysis are located in Appendix B. Since the geochemical conditions at each site are different, the analysis of the data is discussed separately for each location. All inhibition data were compared to standard curves to

determine the concentration of the specific explosive. The standard curves used for quantitation are shown in Figure 15.

**5.1.4.1. Field Standards (Groundwater).** Explosive standards were prepared by R. Araki of U.S. EPA Region 10 Manchester Laboratory for analysis during the initial field demonstration on SUBASE Bangor samples. The concentrations of TNT and RDX ranged from 1-5000 ppb ( $\mu\text{g/L}$ ). Table 2 shows the results from the field analysis by the fiber optic biosensor and the Method 8330 laboratory results. The 1 ppb sample is below the detection limit of the biosensor. At the 10 ppb level, the biosensor was able to detect both RDX and TNT. It is noted that the concentrations determined by the fiber optic biosensor are lower than those obtained by Method 8330 direct injection. By employing an extraction to pre-concentrate prior to Method 8330, the HPLC can detect lower levels. The higher concentrations of 1000 and 5000 ppb were above the percent inhibition levels that can be confidently used for accurate measurements. No dilutions were performed on the higher concentration samples to bring them down onto the curve. Table 2 gives the RPD's for the field standards. At lower detection levels, the RPD's are higher than the acceptable criteria of  $\pm 50$ <sup>18,19</sup> but as stated earlier, small variations at the lower concentrations greatly affect the RPD values.

**5.1.4.2 SUBASE Bangor (Groundwater).** The first field demonstration was performed on monitoring well and GAC effluent samples at SUBASE Bangor. During this demonstration, personnel from the U.S. EPA Region 10 and their contractors were trained to use the Analyte 2000 and the NRL fluidics unit. A summary of the results and the comparison to the independent QST laboratory's Method 8330 are shown in Table 3. Due to variations in fiber probe response and instrument noise (determined from blank samples), a conservative detection limit of 5 ppb was calculated. Some fiber optic samples on Table 3 have concentration values listed lower than 5 ppb rather than below the detection limit (BDL) to give the full range of information on the sensor. The RPD's for RDX ranged from -71 to 164 with an average of 19.7 (Table 3). This average RPD value indicates that the fiber is slightly overestimating the RDX concentrations but is clearly within acceptable range. The samples with higher RPD's also were samples that had large standard deviations for the replicates. For TNT, the RPD's ranged from -38 to 198 with an average of 63.8. The positive RPD value indicates an overestimation of TNT concentration but the larger RPD's values are mostly associated with EW4, which has a value of 13 ppb. As with the RDX analysis, the higher RPD samples have the larger standard deviations for the % inhibition values.

Another way to analyze the fiber optic biosensor data is to perform a linear regression on the data versus Method 8330. In this method, variations at the higher concentrations greatly affect the regression values for the slope. The linear regressions for RDX and TNT on SUBASE Bangor samples are shown in Figures 16 and 17. The samples used for the regression analysis were above the 5 ppb detection limit. The mean and standard deviation from seven or more analyses of each sample are shown. As mentioned above, perfect agreement is indicated by slope = 1.0 with a  $r^2 = 1$ . Slopes less than 1.0 indicate an underestimation of the explosive concentration. For RDX, the slope was 0.58 with  $r^2 = 0.63$ . As shown in Figure 16, there are several points with large standard deviations. The TNT

regression line (Figure 17) has a slope of 0.09 and a  $r^2 = 0.26$ . It should be noted that there are only four points on the TNT curve all at low concentrations.

Based on these results, the two data analysis methods provided conflicting information. Using the RPD, the fiber optic biosensor overestimated. On the other hand, the linear regression analyses indicated that the biosensor underestimated concentration of both TNT and RDX.

**5.1.4.3 Umatilla Army Depot (Groundwater).** The second demonstration was on monitoring well and GAC effluent samples from Umatilla Army Depot. In the period between the two field trials, there was a major change in NRL personnel operating the fiber optic biosensors. The U.S. EPA personnel and contractors remained the same. The summary of the data can be seen in Table 4. Twenty-one samples were analyzed at Umatilla. Most of the samples (17) required dilution to permit quantitation of either TNT, RDX or both. Dilutions at 1:10, 1:50 or 1:100 in water were performed on samples with % inhibitions greater than 70 and the diluted sample re-tested. The fiber optic biosensor and HPLC values of the diluted sample are given in Table 4 and used for all calculations. The RPD's for the Umatilla samples can be found in Table 4. The RPD range for RDX is -72 to 188 and -170 to 187 for TNT. The average RPD's are 16.3 and 39.9 for RDX and TNT, respectively. The average RPD's easily fall into the acceptable range of  $\pm 50$ . The linear regression's for the Umatilla samples are shown in Figures 18 and 19. The slope for the RDX regression is 0.49 with a correlation coefficient of 0.36. If two of the samples (EW-4 and 4-24) are removed, the slope is 0.51 but the correlation coefficient goes to 0.92. The equation for the TNT linear regression is  $y = 0.54x + 14.2$  with a  $r^2 = 0.79$ . The regression analysis indicates an underestimation of the concentrations for both TNT and RDX.

**5.1.4.4 Naval Surface Weapons Crane (Groundwater).** The third field demonstration took place in September at the Naval Surface Weapons Center in Crane Indiana. At this site, there were problems with the assays, later identified in the laboratory as problems with the antibody-coated probes. Due to rapid degradation of TNT, we were unable to repeat the TNT analysis on the Crane samples in the laboratory. We were able to perform RDX analyses on the Crane samples back at NRL and the summary of the data is shown in Table 5. Only one sample required dilution. The RPD's ranged from -126 to -51 with an average of -91.1 (Table 5). This is out of the acceptable range and indicates underestimation of the concentration. This site has very different geochemistry from the other demonstration sites with acidic conditions and significant levels of trichloroethane. The RDX regression line  $y = 0.41x - 0.59$  with a  $r^2 = 0.72$ , indicating an underestimation of the concentration (Figure 20).

**5.1.4.5 Soil Field Samples.** Ten archived, characterized soil samples (TJ00x) from several locations in the United States were provided by T. Jenkins of CRREL. In addition, H. Craig of U.S. EPA Region 10 provided us with five soil samples (Gxx-xx-A) from Umatilla Army Depot, Hermiston OR. A summary of the soil extract results from the fiber optic biosensor and Method 8330 are shown in Table 6. It should be noted that a 1:20 dilution is always performed to get the proper acetone concentration in the test sample that is applied to the

fiber optic biosensor. Because of this dilution, the MDL prior to dilution for a sample is 100  $\mu\text{g/L}$ . Many of the samples required additional dilution to obtain quantitative values from the standard curve. Sample TJ005 extract, which was bright yellow, seemed to cause some problem with the fiber optic biosensor in that it gave values higher than the HPLC value, especially in the TNT assay. As it turns out, this sample contained high levels of picric acid which in a basic form is yellow. The RPD values for RDX ranged from -193 to 94 with the average being -31. Ten samples had RPD's less than  $\pm 50$ . Other than TJ005, only one sample (TJ001) seem to give an artificially high value and that may be due to the high levels of HMX (487835  $\mu\text{g/L}$ ) present in the sample. The TNT assay did not perform as well as the RDX assay. The TNT RPD values ranged from -134 to 195 with an average of -38. Two of the samples gave RPD values less than  $\pm 50$  with five others in the  $\pm 50$ -100 range.

For the T. Jenkins samples, we were supplied with the archived mg/kg values. In the CRREL Special Report 96-10, the authors reported each site has its own extraction efficiency but all were greater than or equal to 70% with the three minute acetone extraction method.<sup>20</sup> Therefore, the  $\mu\text{g/L}$  concentration values were converted to mg/kg employing the assumption of 70% extraction efficiency. The results are shown in Table 7. Six of the eight RDX RPD values were  $\leq 50\%$ . The RPDs ranged from -84 to 174 with an average of 17. Again, the TNT results were not as clean. The TNT RPD values ranged from -154 to 197 (for TJ005) and an average of 7. Only one of seven TNT RPD's fall in the acceptable range.

Another approach for data analysis is to perform a linear regression on the fiber optic results versus Method 8330. In this method, variations at the higher concentrations greatly affect the regression values for the slope. The linear regressions for RDX and TNT are shown in Figures 21 and 22. The mean and standard deviation from seven or more analyses of each sample are shown. For RDX, the slope was 1.28 with an  $r^2 = 0.87$  while the TNT assay gave values of slope = 0.87 and  $r^2 = 0.92$ . Figures 23 and 24 show the linear regression of the calculated mg/kg FOB values for the samples supplied by T. Jenkins. The slope for the RDX assay is 0.95 with an  $r^2$  of 0.99. The slope for TNT (minus TJ005) is 0.21 with an  $r^2$  of 0.64.

**5.1.4.6 False positives/False Negatives (Groundwater).** Following U.S. EPA protocols for false positive/negatives, buffer was spiked at 2X and 0.5X the MDL concentration. The MDL for the fiber optic biosensor for both RDX and TNT is 5 ppb, therefore the concentrations of the spikes tested were 2.5 and 10 ppb. The goal of any field analysis is to identify all samples containing RDX or TNT greater than the stated detection limit (i.e., no false negatives). At the higher concentration (10 ppb), there were no false negatives in either the RDX or TNT spiked samples (Table 8). Samples which do not contain explosives should also be accurately identified. With the lower concentration (2.5 ppb), there were 42% and 62% positives for RDX and TNT, respectively. The high level of positives at 2.5  $\mu\text{g/L}$  can be partially explained by the standard curve and variability. The standard curves for RDX and TNT are asymmetric sigmoids which are linear in the middle range and gradually level off at the lower and upper ends of detection. This makes it difficult to establish a precise limit of detection. If the cut-off for detection was exactly 5  $\mu\text{g/L}$ , none of the 2.5  $\mu\text{g/L}$  samples would have been positive. The variability between analyses can also affect the number of positives. With mass production of the antibody-coated fiber optic probes, there

should be less variability due to improved QA/QC, therefore the MDL could be lowered to reduce the false positives without increasing the false negatives.

**5.1.4.7 Cross-Reactivity (Groundwater).** Both the limits of detection and the concentration at which 50% inhibition of the maximum signal ( $IC_{50}$ ) occurred were determined for TNT and RDX (Table 9). Values greater than 1000  $\mu\text{g/L}$  indicate no detectable inhibition. For the anti-TNT antibody from Strategic Diagnostics, only 1,3,5 trinitrobenzene (TNB) showed any appreciable level of cross-reactivity with detection at 10  $\mu\text{g/L}$  and the  $IC_{50}$  at 50  $\mu\text{g/L}$  (Table 9). Other compounds were detected with this antibody but did not achieve 50% inhibition of the signal for concentrations less than 1000  $\mu\text{g/L}$ . This cross-reactivity to TNB is expected as the antibody was raised against a TNB conjugate. TNT could not be used because it is not immunogenic. There were not significant cross-reactants with the anti-RDX antibody at the  $IC_{50}$  level. Only HMX had any significant limit of detection with the anti-RDX antibody.

**5.1.4.8 Matrix Effects (Groundwater).** The effect of different matrices on the explosive assays were examined by spiking each matrix with a high and low concentration of explosives. The results of this study are shown in Tables 10 and 11. The bias is the indication of how accurate the assay was (i.e., the similarity of the measured concentration to the spiked concentration). In all cases the higher concentration was more accurate or had a higher bias than the lower concentration. It should be noted that the % inhibition values were used to determine the bias and precision. The standard deviation from the % inhibition values was then converted to ppb to calculate the MDL and RQL values. The reason for this is the high TNT concentration is not on the linear portion of the standard curve. The inhibition values are at the level where dilutions should be performed to quantitate the sample. Very small changes have dramatic changes in the concentration values, which make the standard deviations very large. The TNT assay appears to have better values for the bias than the RDX assay. The precision varied in both assays but at the higher concentrations were less than 15%.

Overall, the fiber optic biosensor performed well in the field and laboratory trials. Improvement in QA/QC should help reduce variability and therefore improve quantitation reliability. This biosensor is near the screening detection limit for groundwater with 5 ppb vs 2 ppb, respectively and meets the requirements by having no false negatives at twice the MDL.

## **5.1.5 Continuous Flow Immunosensor**

**5.1.5.1 Field Standards (Groundwater).** The initial field demonstration conducted at SUBASE Bangor involved preparation and analysis of explosive standards (TNT and RDX). The explosive standards prepared at SUBASE Bangor served as calibrants while analyzing groundwater samples. Each explosive standard was analyzed by the FAST 2000 immunosensor in a series of 7 injections (0.150 mL). A fluorescence peak area from the FAST 2000 immunosensor was recorded for each injection. The explosives concentrations for each injection were calculated by comparing fluorescence peak areas of standards to

samples, as described in Sec. 4.4.2. As seen in Table 12, RDX standards analyzed by the FAST 2000 were consistent with the calculated value measured by QST Environmental Lab (e.g. FLS-8; 113 vs. 97). Standard deviations ranged from as low as 8% to as high as 31%. However, the highest standard deviation was only evident at the lowest concentration of 1.0 ug/L, where slight changes can skew standard deviation values. Calculated concentrations of TNT for the explosive standards (FLS-1 thru FLS-5) were also close to the expected values, determined by QST Laboratory. However, standard deviations were higher than expected, ranging from 16% to as high as 114% (FLS-4). A possible factor for the increased standard deviations is the low binding affinity of the anti-TNT antibody (11B3). Low affinity of the antibody to the explosive molecule, TNT, can result in fluorescence peak area differences seen even with multiple injections of the same standard solution.

Statistical calculations of the field data were performed as a measure of performance for the FAST 2000 immunosensor in the analysis of explosives in groundwater. One such analysis performed was relative percent differences (RPD). Calculated RPD's for the TNT and RDX field standards (Table 12) range from -30% to 61%. From the RPD calculations only 1 sample was higher than  $\pm 50$  (FLS 2). In general, low RPD values (near zero) indicate the closeness of the two analytical methods (FAST 2000 immunosensor versus HPLC). The average RPD value of 10% is a good indication that the FAST 2000 was quite accurate in the determination of the explosive standards. However, a value as high as 50% seen in a standard could suggest a number of factors could be influencing the assay. Such factors could include fluorescence depletion on the membrane causing less displacement of fluorescence analog or variance in flow rates from instrument to instrument. Fluorescence depletion leading to decreased displacement efficiency will result in an underestimation of explosive standards and higher RPDs.

Linear regression analysis was also performed on the field standards. As mentioned earlier, the goal is to have a slope = 1.0 with a  $r^2 = 1.0$ . The RDX standards yielded a regression line of  $y = 0.76 + 6.01x$  with a  $r^2 = 0.99$  (Figure 25). The line for TNT was  $y = 0.78 + 58.25x$  with an  $r^2 = 0.99$  (Figure 26). This indicates the FAST 2000 is slightly underestimating the explosive concentration.

**5.1.5.2 SUBASE Bangor (Groundwater).** At SUBASE Bangor, 13 groundwater samples were analyzed by the FAST 2000 for RDX and TNT content. Calculated concentrations of RDX determined by the FAST 2000 immunosensor from samples, listed in Table 13, were within a factor of 2 of the value determined by QST Laboratory. Although, some groundwater samples (e.g., EW-8) analyzed for RDX by the FAST 2000 immunosensor were very accurate, most of the samples analyzed were lower in RDX concentration when compared to QST Laboratory.

Analyses of TNT content between the FAST 2000 and QST Laboratory were different. TNT concentration values listed in Table 13 revealed most of the samples were below the detection limit of the FAST 2000, but did illicit a positive response (e.g., EW-9). Although the anti-TNT antibody (11B3) is specific for TNT it does exhibit minimal cross-reactivity to other compounds, which could result in an inaccurate response. Another possible

explanation for the difference between the FAST 2000 immunosensor results and the HPLC analysis is the incorporation of an extraction method. A salting-out extraction method performed by QST Laboratory was used to obtain sufficient quantities of TNT for SW-846 Method 8330 analysis. This extraction method may decrease the actual concentration of the sample below the detectable limit of the HPLC. The result is a negative response when explosive material in trace quantities may be present. As a result of the TNT data, further experiments were conducted to improve assay performance.

RPD values were calculated for 13 groundwater samples containing TNT and RDX (Table 13). From these results, calculated RPD's were much higher than what is normally accepted. RDX RPD values showed that 7 out of the 11 samples with numerical values gave negative RPD values. Of those negative samples, 3 were above the -100% threshold (EW-3, EW-4 and INF-1) revealing a lowered estimation of RDX concentration by the FAST 2000 immunosensor compared to the certified laboratory method (SW846-Method 8330). From the remaining 4 positive RPD values, only 1 (BET-1) was above the +100% threshold.

Another method for analyzing the field data is linear regression. Figures 27 and 28 show the plots for RDX and TNT at SUBASE Bangor, respectively. The regression line for RDX is  $y = 0.67x - 0.04$  with a correlation coefficient ( $r^2$ ) = 0.56. TNT gave a line of  $y = 0.61 + 7.54x$  and a  $r^2$  of 0.96. In both cases, the slope suggests an underestimation of the explosive.

**5.1.5.3 Umatilla Army Depot (Groundwater).** Using lessons learned from SUBASE Bangor, the second series of field tests at Umatilla Army Depot showed significant improvements in the estimation of RDX and TNT by the FAST 2000 immunosensor. Of the 21 groundwater samples (Table 14) analyzed by QST Environmental Laboratory, there were no false positives (a positive response by the FAST 2000 when QST has estimated below the minimal detectable limit) measured by the FAST 2000 immunosensor. The values listed in Table 14 for RDX concentrations determined by the FAST 2000 were in close proximity to that of QST laboratory. Only values below the MDL of the FAST 2000 (25 ng/mL) were estimated as below detection limit (BDL). Two samples (4-114 and EW-1) were considerably off the value obtained by QST Laboratory. Samples 4-114 and 4-114D were duplicate samples but showed 10 fold difference in the values measured by Method 8330, suggesting a sampling problem rather than a problem with the analytical methods used. RDX concentrations measured by the FAST 2000 in some groundwater samples were very accurate (e.g. EW-3, EW-4 and Combo 2). Determination of TNT concentration also improved on groundwater samples measured by the FAST 2000. Groundwater samples measured by the FAST 2000 containing mid to high concentrations of TNT (e.g. Combo-2, 9, and 4-112) were accurately measured compared to those containing lower TNT concentrations (4-113 and 4-114). This response could be due to a groundwater matrix interferant that can complex with the explosive material, preventing recognition by antibody binding sites, causing no displacement of the fluorescent antigen.

Calculated RPD values (Table 14) show good correlation between the HPLC method performed by QST Laboratory and the FAST 2000 immunosensor. Of the 21 groundwater samples analyze for RDX, 7 of the 14 with numerical values above the detection limit were

inside the acceptable  $\pm 50\%$  range. Only 2 samples (4-102 and EW-1) were above the -100% threshold. There were 9 out of 21 groundwater samples analyzed for TNT by the FAST 2000 immunosensor that were above the MDL and 3 of those samples were inside the acceptable  $\pm 50\%$  range. Three of those 9 samples gave values above the +100% threshold.

Linear regression plots for RDX and TNT at Umatilla Army Depot also indicated improvements in slope and  $r^2$  for both analytes (Figures 29 and 30). For RDX, the regression line was  $y = 0.73x - 41.37$  while the line for TNT was  $y = 0.72x - 13.65$ . The correlation coefficients ( $r^2$ ) were 0.81 and 0.84, respectively. Even though there was improvement, the immunosensor still biased low on the explosive concentrations.

**5.1.5.4 Naval Surface Weapons Center, Crane (Groundwater).** RDX and TNT analysis of 16 groundwater samples by the FAST 2000 at the Naval Surface weapons Center provided the most accurate and precise analysis of all the field demonstrations (Table 15). One sample showed a clear false positive (10C57R - RDX) with another being an order of magnitude lower than the 8330 results (03C08 - TNT) and a second that was an order of magnitude higher than expected (Spring - TNT). The false positives can be explained by matrix effects at this level. The "Spring" sample by Method 8330 gave a result that is right at or below the MDL set for the FAST 2000. We have seen, particularly at the NSWC Crane, that the groundwater matrices can have a pronounced effect on the results when the explosive concentration is right at the detection limit of the instrument. Efforts to improve the TNT immunoassay were rewarded with most groundwater samples estimated by QST Laboratory being correctly estimated by the FAST 2000. Most of the groundwater samples were low in TNT concentration or below the detectable limit of the FAST 2000, but still were correctly estimated. The mean RDX RPD value for concentrations other than BDL was 10% (Table 15). Estimation of the mean TNT RPD value could not be accurately determined, since most values were below the detectable limit and possessed no numerical value.

Linear regression plots for RDX and TNT at NSWC Crane show correlation coefficients ( $r^2$ ) of 0.59 and 0.65, respectively (Figures 31 and 32). It should be noted that if sample 03C09 was omitted the  $r^2$  for RDX would be 0.91. The correlation coefficient for the TNT regression plot is low due to the number of data points (4). This is a result of most samples being below the detection limit (BDL) which gave no numerical value. The slopes for the regression lines were 0.73 and 0.40 for RDX and TNT, respectively. Since the slopes are less than one, the sensor is underestimating the explosive concentration. At this point it should be noted that the slopes for Umatilla, Crane and the field standards range were 0.73, 0.73, and 0.76 for RDX. The same slope range is seen with TNT at Umatilla and the field standards (0.77 and 0.72). If this is a consistent trend, a correction factor could be employed to yield results very close to Method 8330.

**5.1.5.5 Soil Field Samples.** The same samples as those described for the fiber optic biosensor were also analyzed by the continuous flow immunosensor. It is important to keep in mind, that after the acetone extraction, 1.5 mL of the sample was dried down in a test tube with nitrogen and rehydrated with flow buffer for analysis. Table 16 shows the results from the continuous flow immunosensor and Method 8330. As with the fiber optic biosensor,

sample TJ005 caused some problems in the analysis for both the TNT and RDX assays. The RPD values for RDX ranged from -195 to 122 with an average of -13. Eight of the fifteen values were less than  $\pm 50$ . The TNT RPD values ranged from -40 to 199 with the average value being 86. Four of the samples were in the acceptable ( $\pm 50$ ) RPD range. Several of the samples contained levels of TNB equivalent or greater to those of TNT. As mentioned earlier, the 11B3 antibody is highly cross reactive to TNB which may explain the high values for the FAST 2000 TNT assay. If the TNT and TNB combined concentrations are used for the Method 8330 values (data not shown), the RPD's ranged from -40 to 199 (TJ005) with an average of 21. Nine of the thirteen RPD values are below  $\pm 50$ .

As with the fiber optic biosensor, the values for the soil extracts was converted to mg/kg soil using a 70% extraction efficiency. The results are shown in Table 17. The RDX RPD's ranged from -99 to 114 with an average of -7 while the TNT RPD's ranged from -51 to 199 with an average of 100. At this time, we do not have values from T. Jenkins for TNB to do a comparison to the combined TNT+TNB mg/kg soil concentration. Five out of eight of the RDX positive values and two of eight are in the acceptable RPD range.

The linear regression analysis of the soil extracts are shown in Figure 33 and 34. With the RDX analysis, TJ008 which is very high in HMX as well as TJ005 cause the linear regression to give a slope and correlation coefficient (1.34 and 0.68). If TJ005 and TJ008 are removed, the slope improves to 0.94 and the  $r^2$  value goes to 0.75. A similar trend is seen with TNT. In this case, TJ005 and TJ006 effect primarily the correlation coefficient with some effect on the slope as can be seen in Figure 34. The slope improves from 0.91 to 1.02 and the  $r^2$  improves from 0.44 to 0.81 with the removal of values for TJ005 and TJ006. In Figure 35, the FAST 2000 results are compared to the combined concentrations of TNT+TNB. As can be seen in this figure, the slopes and regressions are improved for the entire data set. This can also be observed with the mg/kg values for the samples from T. Jenkins in Figures 36 and 37. The slope for RDX is 1.56 with TJ005 and TJ008 and 1.11 without them. The  $r^2$  values are 0.84 and 0.997 respectively. The TNT assay with the removal of TJ005 and TJ006 gave a slope of 1.08 with an  $r^2$  of 0.79.

**5.1.5.6 False Positives/False Negatives (Groundwater).** Experiments were conducted with the FAST 2000 to determine the false positive/ false negative percent for TNT and RDX (Table 18). The definition of a "false negative" is a negative response for a sample that contains 2 times the stated detection level of the target analyte. A "false positive" is a positive response for a sample that contains analyte at one-half the detection level. The minimal detection limit with the FAST 2000 in the system flow buffer is 10 ng/mL. The false positive (FP) / false negative (FN) experiments involved 20 -30 replicate injections of TNT or RDX at concentrations at 5 ng/mL (FP) and 20 ng/mL (FN) into the FAST 2000 immunosensor (Figures 37 and 38). Explosive samples were prepared in the system flow buffer into the FAST 2000. Fluorescence dose responses were recorded from the immunosensor and calculated. Results showed 0% false positives and 0% false negatives.

**5.1.5.7 Accuracy and Precision (System Flow Buffer).** Two other performance criteria are accuracy and precision. Accuracy is an indication of how closely the average value of the

FAST 2000 immunosensor matches with the HPLC confirmatory method (SW846-Method 8330). Precision is an indication of how close the replicate injections into the FAST 2000 are to each other. Listed in Table 19 are results from the accuracy and precision experiments in which RDX and TNT (5 and 50 times the detection limit) are applied to the FAST 2000. Explosive samples are prepared in system flow buffer and injected 7 - 9 times into the sensor. Results indicate a high degree of accuracy between RDX and TNT with values that range from 93% - 99%. The precision of the sensor is also indicated with percentages that are as low as 6% up to 15%.

**5.1.5.8 Accuracy and Precision (Groundwater Matrix Spikes).** To determine the effect of groundwater matrixes on the analysis of TNT and RDX by FAST 2000 immunosensor, a series of experiments was performed. The first set of experiments required supplementing 3 different groundwater matrices (SUBASE Bangor, Umatilla Army Depot and Volunteer Army Ammunition Plant) with TNT and RDX at concentrations 5X and 50X the minimal detection limit. Each groundwater matrix selected contained little to no explosive content. The groundwater spiked matrices give an indication of the environmental interferents that could pose problems for immunoassays. Analysis by the FAST 2000 involved 7 injections of each spiked groundwater matrix onto the respective antibody/ fluorescence antigen membrane complex. The fluorescence displacement area was recorded and translated into accuracy (%) and precision (%). Results indicated in Tables 20 and 21 show a wide percentage fluctuations with the matrix spikes in comparison to the system flow buffer spikes. TNT accuracy results ranged from 68% to as high as 653%. This high value (653%) can be attributed to an interferent in the groundwater matrix that caused non-specific displacement of the fluorescence analog. This dramatic increase in fluorescence caused the data to be skewed on the higher end. Of the other matrix spikes, all were relatively accurate (within a factor of 2) in the measurement of TNT. Precision values were as low as 10% to as high as 86%. RDX accuracy measurements were not skewed as much as TNT. RPD results show percent accuracy ranged from 20% to as high a 96%. Precision results ranged from 9% to 59%. Data calculations also reveal that the FAST 2000 immunosensor was less affected by the matrix interferent at the higher concentrations than at the low end. Overall, the FAST 2000 was able to detect TNT and RDX with reasonable accuracy but did encounter matrix associated problems at each location. Elemental analyses of groundwater samples taken at one site (Volunteer Army Ammunition Plant) showed enormously high concentrations of sulfate, magnesium, carbon and alkalinity. In essence, the FAST 2000 can detect explosive contaminants but like most other immunoassay techniques can encounter problems associated with the natural environment. Efforts to remove the environmental interferent by solid phase extraction are being investigated.

**5.1.5.9 Cross-Reactivity (Groundwater).** Another performance criterion for the FAST 2000 immunosensor is its ability to select and measure the unlabeled RDX or TNT molecule among other explosive compounds. To demonstrate the RDX immunosensors selectivity, a series of standard solutions containing various explosive compounds at 1000 ng/mL was injected into the immunosensor. As a calibrant, unlabeled RDX was also injected at the same concentration. After each injection of explosive samples, fluorescence integrated area from the displaced fluorescent RDX analog was recorded and compared to the fluorescence integrated area of the

RDX standard (used as 100% value). Similar experiments were performed to determine TNT antibody cross-reactivity using 250 ng/mL as the explosive concentration. Exhibited in Table 22 are the percent cross-reactivity results of each explosive compound compared to unlabeled RDX and TNT measured by the FAST 2000 immunosensor.

Results exhibited minimal cross-reactivity of other explosive compounds in the RDX FAST 2000 immunosensor. Percent cross-reactivity values ranged from as low as 0.9% (Tetryl) to 4.8% (HMX). The average percent cross-reactivity was approximately 2% for all compounds tested. One of the highest cross-reactivity values obtained was with HMX at 4.8%. It is reasonable to assume that the HMX molecule would exhibit high cross-reactivity results in the RDX immunoassay because of similar structural characteristics. Molecules such as TNT and its breakdown products, 2-amino-4,6-DNT, TNB and nitrobenzene show less cross-reactivity than HMX. This is expected because explosives similar in structure to TNT possess a planar conformation and not the chair conformation exhibited in RDX. Increases in percent cross-reactivity, evident with nitrotoluene (NT) and trinitrobenzene (TNB), may result from resonance and electrical field effects from the electronegative charge distribution from nitro groups oriented on the benzene ring. These series of tests for cross-reactivity in the RDX FAST 2000 immunosensor demonstrate that other explosive compounds such as TNT and its breakdown products exhibit minimal non-specific fluorescence response. However, that fraction of cross-reactivity is minimal and is most likely to occur due to like characteristics of all explosive compounds. These results confirm the high selectivity for RDX in the FAST 2000 immunosensor and its ability to screen out interferents that generate erroneous signal responses.

TNT cross-reactivity experiments performed with the FAST 2000 immunosensor involved injection of a series of standard solutions containing various explosive compounds at 250 ng/mL similar to that of the RDX immunoassay. As a calibrant, unlabeled RDX was also injected at the same concentration. Results shown in Table 22 show a 600% increase in cross-reactivity to trinitrobenzene (TNB). This is to be expected given the 11B3 anti-TNT antibody was raised against a TNB hapten complex. High cross-reactivity results of this nature can be positive given that many of the breakdown products of TNT are TNB and/or amino-DNT. Molecules such as TNB and its breakdown products, 2-amino-4,6-DNT, Tetryl and nitrobenzene are more cross-reactive than HMX or RDX because of their similar structural characteristics. Explosives similar in structure to TNT possess a planar conformation and not the chair conformation exhibited in RDX which allow better recognition of the molecule to the anti-TNT antibody.

## 5.2 Data Assessment

**5.2.1 Groundwater.** Since evaluation of the biosensors depends on the result of Method 8330, steps were taken to have useable data. In addition to the main contract lab (QST), NRL performed in-house HPLC analysis of all samples. Selected samples from Umatilla, Crane, Volunteer, and Louisiana were analyzed by a second laboratory (GP Laboratories). Figure 14 shows the correlation of NRL's HPLC results versus QST. As can be seen, the correlations are excellent giving us confidence in the Method 8330 results used for comparative analysis.

Some problems have been identified with the fiber optic biosensors during the field trials. These problems appear to be associated with the fiber optic probe preparation. One problem dealt with antibody immobilization that affected the quantity of the antibody immobilized on the surface. The other problem was the fiber optic probes were not tapered down to the appropriate diameter required for maximum excitation and fluorescent collection. These problems were due in part to improper training of new personnel. These issues have been addressed. There are still some problems with variability of fiber probes that should be improved when the probes are mass produced.

**5.2.2 Soil.** The results from the immunosensors were compared to Method 8330 run on the acetone extracts to eliminate the variations in extraction efficiency due to the source of the soil.<sup>20</sup> We used the field acetone extraction method but other extraction method could be employed. The fiber optic biosensor used the acetone extract directly but the continuous flow method required drying down the acetone extract and redissolving in flow buffer. It is not clear if this concentrates other compounds which could be interfere with the assay.

### 5.3 Technology Comparison

**5.3.1 Groundwater.** There are several commercially available immunoassay test kits and a colorimetric test kit for the explosives TNT and RDX. In 1997, Craig et al compared several of these field methods<sup>1</sup>. Currently, the U.S. EPA is putting together a report on field methods for explosives in groundwater<sup>19</sup>. From these documents, a chart comparing the different technologies was developed (Table 23). Table 23 indicates that the biosensors are in the range of the other methods for detection with the exception of the RaPID Assay and the salting-out procedure for Method 8330. The salting-out extraction takes several hours to perform where as the biosensors do not employ an extraction/concentration step. Usually the direct injection procedure with Method 8330 is used when the suspected explosive concentration is above 20 µg/L which is higher than the detection limit of the biosensors. The RaPID system is only useful and cost-effective if batches of 10-40 samples are being analyzed simultaneously. The on-site method currently being used at several Superfund sites is the EnSys RIS system. The biosensors have several advantages over this method including analysis time, a substantial reduction in solvent, solid, and chemical waste generated, and data integration capabilities. Currently, the biosensor devices are commercially available but the antibody-coated matrices (fiber or membrane) are not. Research International is pursuing partnerships with other companies to make those items commercially available.

**5.3.2 Soil.** As with groundwater, there are several commercially available test kits for the detection of TNT and RDX in soils. Crockett et. al. compared several of these analytical methods and described them in a 1998 CRREL Special Report.<sup>22</sup> From this document, a chart comparing the different technologies with the NRL immunosensors was developed (Table 24). All the methods require some sort of soil extraction prior to analysis. Of the methods listed on Table 24, only one, the RaPID assay, does not use acetone as the extraction solvent. Of the assays using acetone, most use a 5:1 (V:W) solvent to soil ratio for extraction. The continuous flow immunosensor and the Ohmicron RaPID assay give the lowest limits of detection of the test kits. The fiber optic biosensor is in the range of the other methods, if not slightly lower MDL. The

current on-site soil method being used at several Superfund sites is the EnSys RIS system. As with the groundwater comparisons, the NRL biosensors have several advantages over most of these methods including sample analysis time, and reduction in waste. As stated earlier, the instruments are commercially available but not the antibody-coated matrices.

## 6. Cost Assessment

### 6.1 Cost Performance

#### 6.1.1 Startup Costs.

**6.1.1.1 Fiber Optic Biosensor.** Currently, the fiber optic device is commercially available (~\$18K) but the optical probes are not. NRL developed a semi-automated microfluidics unit for the addition of samples and reagents which is not commercially available but made from commercially available parts. The estimated cost of this unit is \$8K. A computer (i.e., portable or laptop) is needed to operate the current fiber optic device via an RS232 port. In addition to the device and probes, there are some initial supplies (~\$800) that are suggested but not required including adjustable pipettors and graduated cylinders. As the system is fully automated, the need for the pipettors will be eliminated. At the present time, a person with laboratory training is needed to operate the sensor but with automation this requirement will be diminished as will the labor costs. Little, if any, cost is associated with site preparation and permits other than obtaining the water samples. The fiber optic biosensor can be battery operated or run off a line source (110V). It is recommended that the current biosensor be operated out of direct sunlight. Refrigeration of the stock solutions is the optimum storage condition but is not required. Stock solutions can be lyophilized for long term storage ( $\pm 1$  yr) and rehydrated when needed with short term storage up to 1 month without refrigeration. The physical requirements pose minimal additional costs to the startup. Antibody-coated fibers may be stored more than 1 year lyophilized at  $\leq 25^{\circ}\text{C}$  or in buffer at  $4^{\circ}\text{C}$ .

**6.1.1.2 Continuous Flow Immunosensor.** The FAST 2000 was designed to be a field portable, single-channel instrument that uses a displacement immunoassay for detection of analytes. Currently, ten instruments have been produced by the manufacturer, Research International, at a cost of approximately \$21,000/per instrument. The cost reflects the “custom” engineering of each instrument to date-- such factors as machining of individual parts, etc. Fluidics and hardware to maintain precise flow control during each analysis, software development costs are also involved.

Assay times are generally 2-4 minutes, allowing approximately 40-50 analyzes per day. Set up and shut down can be completed in 15-20 minutes. Additional supplies required to run the instrument include the disposable coupons (\$49/each) which are individually assembled and the

antibody coated membranes/fluorescent analogs, prepared at NRL. RI is currently discussing several options for full-scale commercialization of the instrument, which would include injection molded coupons (reducing the cost to pennies per coupon), and membrane preparation by a company that currently sells immunoassay kits and produces TNT/RDX antibodies.

**6.1.2 Operations and Maintenance.** The consumables (buffers, pipet tips, syringes) for the fiber optic biosensor are estimated to be \$110/wk and are included in the \$3-5/sample cost. Additional costs for acetone soil extractions are estimated at \$1 - \$1.50 per sample. Minimal training is required to operate the fiber optic biosensor. It can be run continuously or intermittently to allow for spot monitoring. For most groundwater monitoring during cleanup, intermittent (daily, weekly) monitoring is performed. The fiber optic sensor can be setup and assays run within an hour. Minimal waste is generated by the operation of the biosensor. Little maintenance of the Analyte 2000 has been required during the last four years of operation at NRL.

General operation of the FAST 2000 requires consumables similar to those needed for the Analyte 2000 (buffers, pipet tips, syringes, sample tubes), with an estimated cost of \$3-5 per sample. Training of operators with technical backgrounds (engineers, environmental project managers) can be done in several hours. As discussed in the manual provided with the FAST 2000, maintenance of the fluidics in the instrument is essential to continued optimal performance. A shutdown routine is part of the software and provides an easy means of cleaning the instrument effectively after each use. More complete maintenance of the instrument to replace tubing or service the internal pump would require return of the instrument to the manufacturer, RI.

**6.1.3 Demobilization Costs.** There are no costs associated with the demobilization of these biosensors.

## **6.2 Cost Comparisons to Conventional and Other Technologies**

Tables 25 and 26 give a comparison of cost for the commercially available methods for explosive analysis in groundwater and soil, respectively. The initial set-up costs for the biosensors are high compared to the other technologies but the ongoing cost per sample is very low compared to the other methods. For a typical long-term groundwater remediation program, 50 to 150 samples will be tested per year (excluding quality assurance samples and individual extraction wells) for 10 to 30 years. Craig et al. estimated that after 500 samples, money is being saved by employing the biosensors versus the currently employed EnSys RIS method<sup>1</sup>. Both the EnSys RIS method and the NRL immunosensors currently require operation by personnel with some laboratory experience or with field analytical methods (Tables 23 and 24). The FAST 2000 is being automated so personnel with low skill level will be able to operate the instrument, thereby reducing labor costs.

## **7. Regulatory Issues**

### **7.1 Approach to Regulatory Compliance and Acceptance**

All field demonstrations were planned and executed with the assistance of Harry Craig, U.S. EPA Region 10. The three field sites are currently undergoing remediation and therefore, have well-established plans for handling samples generated on base during the test period. At each site, the regulatory personnel were informed of the field demonstration. At two of the trials, Roy Araki, a chemist from U.S. EPA Region 10's Manchester Laboratory, assisted with the immunosensor analysis. In addition to the personnel directly involved with the field trials, Barry Lesnick of the U.S. EPA Office of Solid Waste was consulted to make sure all necessary information was being collected for submission for method approval.

Based on data contained in this final report, methods were drafted on both the fiber optic biosensor and the continuous flow immunosensor for groundwater and submitted to U.S. EPA Office of Solid Waste. Soil methods are in preparation. The working group under the direction of Barry Lesnick has given their authorization to continue with the method approval process. These methods are not designed to replace HPLC analysis but are to be used in conjunction with Method 8330. Confirmatory testing with Method 8330 would be performed on a minimum of 10% of the samples analyzed by the biosensors.

## **8. Technology Implementation**

### **8.1 DoD Need**

The average cost for a single sample analysis is \$250 for SW 846 Method 8330. It is estimated that monitoring of groundwater at a single site during remediation is \$35,000 per year and the length of time for monitoring will be a minimum of 20 years.<sup>1,19</sup> This cost does not take into account lost work time waiting for the results of the analysis. On-site analysis will greatly reduce the overall cost of monitoring. There are 20 Superfund sites and many other sites contaminated with explosives that will require monitoring for an extended period of time.

### **8.2 Transition**

The groundwater field trial results have been incorporated into a submission to the U.S. EPA with the goal of obtaining an immunoassay method number under OSW 846 within the next six months for both sensors. NRL was responsible for submitting the OSW paperwork to the U.S. EPA. To guide our efforts, we have had ongoing conversations with Barry Lesnick at the U.S. EPA. Barry Lesnick and the technical working group have examined the validation data submissions and given positive comments.

Research International has also licensed key patents related to the fiber optic biosensor. Current focus of this technology has been on the development of a fully automated system for the U.S. Marines and Special Forces for the detection of biological warfare agents (BW) (proteins,

toxins, bacteria, etc.). DARPA and ONR have jointly funded a Phase II SBIR to produce inexpensive, manufacturable fiber optic probes for the biosensor. SERDP has funded a project for the proof of principle for deployment of the fiber optic biosensor into a cone penetrometer for detection of explosives. In addition to the BW and explosive applications, collaborations with NSWC Carderock and Tulane University are adapting the Analyte 2000 for the detection of polyaromatic hydrocarbons and heavy metals, respectively. Assays for the rapid detection of sepsis markers with the Analyte 2000 are being pursued in a collaboration with WRAIR and AGEN Biomedical, LTD. The market for a fast, sensitive sepsis test includes not only medical diagnostics and casualty care but also food processing and beverage production.

The FAST 2000 has been commercialized by Research International. The company has licensed the NRL patent for the technology, has sold several instruments to the U.S. EPA, and is actively pursuing marketing partners and possible market niches. RI is working with NRL to solve the problems identified with instrument reliability. To overcome problems with matrix effects at the low ends of detection, the U.S. EPA is providing additional samples for screening. These field samples will be prepared as before, with simple buffer addition, and will also be pre-treated using a solid phase extraction protocol.

The most effective pathway for transferring this technology is through the current FAST 2000 manufacturer, Research International. The company has built 10 instruments, has actively exhibited the instrument at major trade shows, has indicated its commitment to commercializing the technology by signing a licensing agreement with NRL and is actively holding talks with several larger companies that would serve as marketing/development partners. The manufacturer has been involved with technical assistance and instrument maintenance throughout this process. The company has made modifications as required to improve field trial performance.

## **9. Lessons Learned**

### **9.1 Groundwater.**

Several lessons were learned regarding the fiber optic biosensor during these field trials. The main lesson was the need to make sure the QA/QC procedures for the preparation of the antibody-coated fiber optic probes are clearly stated and emphasized to all. This is especially true with new personnel. Another point that needed to be addressed was determining when the fiber optic probe was no longer useable for data analysis. Several times at the first field demonstration, analyses of samples were performed on fiber probes that were no longer functioning optimally. Also from these trials it was noticed that possible instrument problems that may occur, both the symptom and possible cause, should be written out for the operator. This is important as several of the Analyte 2000s, which have been use heavily for 3-4 years, are now hitting their lifetime. Variability in laser power is one problem in the older, heavily utilized instruments. Overall, the Analyte 2000 is a durable instrument but all things have a limited

lifetime. Fluidics problems such as clogging, leaks, etc., are something that any instrument working with real world samples will have to address. The symptoms, possible causes, and solutions need to be stressed to the operator so time, reagents, and samples are not wasted.

In addition to issues with the instruments, matrix effects were observed with the fiber optic biosensor. The importance of filtering the samples was clearly demonstrated in the field, as the presence of particulates and/or cloudiness was observed in many samples. The standard curves which are used for quantitation are created from explosive spikes into distilled water. Under ideal conditions, which should reduce or eliminate matrix effects, the standard curves should be created with explosive spikes into blank water from the test site.

For the flow immunosensor, early results with the FAST 2000 varied widely, most probably due to the nature of the dose/response curve of the analysis. At the conclusion of field trial 1 (SUBASE Bangor), an improvement was implemented in the immunoassay protocol, i.e., the insertion of more internal standards during the 7 injections of each groundwater sample to achieve a closer approximation of the unknown concentration. This modification to protocols and recognition of constant fluorescence depletion of the membrane with time proved important for later accuracy and precision measurements by the FAST 2000 immunosensor. In addition, some technical expertise with other EPA methods would, in our opinion, be necessary to understand and fully use the instrument as is. This is primarily due to the complex nature of the response of the instrument to the analyte over the time of the instrument usage.

Additional lessons were learned from the studies on matrix interferences. As seen in the results, we found that differing hydro-chemistries affected final determinations of TNT/RDX at each site. In the flow immunosensor protocol, samples are generally tested without dilutions, extractions or selective prefiltration. In fact, even after general filtering to remove particulates, the results for several samples varied widely. Matrix effects are a major concern, since especially high salt concentrations or other compounds may interfere with antibody selectivity and binding. In a few sample matrices, a slight change occurred in the background signal just before the sample signal was observed on the continuous flow sensor. This change was usually observed as a decrease in the background signal but, in a few cases, the signal intensity showed a slight increase or spike above the background value. This may be due in part to the use of highly purified water in preparing the standards. In any event, in no case did we observe the matrix to hide the signal of even the lowest standards tested.

To correct for the majority of matrix effects, we recommend preparing and analyzing field standards in a blank water sample acquired from each remediation site prior to running actual samples. Matrix effects may still be present but will essentially be normalized after all the calculations have been performed. To run matrix spikes, "blank" groundwater from the remediation site (defined as having TNT and RDX concentrations below the MDL of Method 8330) is spiked with TNT/RDX concentrations 5 and 50 times the MDL of the FAST 2000 (i.e., 10 ng/mL). Replicates of these matrix spikes (50 and 500 ng/mL final concentration) are then tested in the FAST 2000 and compared to standards of identical concentrations. These changes have been incorporated into the SOP's.

It became clear with both systems that further studies into sample preparation to prevent matrix effects would greatly improve the bias and precision of the sensors. Solid phase extraction (SPE) is the preferred method that we explored to both reduce matrix contaminants which affect the assays and to improve detection limits by preconcentrating the sample. In limited laboratory tests performed using SPE samples, we found it to be an effective way to improve overall assay reliability. Also, SPE is also suggested for those sites where samples are at the lower end of the method detection limit.

## **9.2 Soil.**

The analysis of soil samples for TNT and RDX, using the FAST 2000, requires an extraction of the explosive material from the soil. For this study, we utilized a field method of extraction developed by Tom Jenkins (CRREL) that can be performed in less than five minutes. The method dictates that 20g of soil be mixed with 100 mLs of acetone, in a certified clean vial, and shaken for 3 minutes. The mixture then sits for a short period of time to allow the particulates to fall out of suspension. The fiber optic biosensor uses the acetone extract directly, replacing the 5% acetone in the sample fluorescent solution, thereby performing a 1:20 dilution. This raises the limit of detection by 20. In the continuous flow immunosensor method, sample preparation involves placing 2 mLs of the extraction supernatant into a test tube and removing the acetone using an argon stream. The remaining material is then brought up in 2 mLs of the assay buffer. Direct injection of the prepared sample and subsequent analysis allow for semi-quantitative analysis of the soil.

In addition to lessons learned with groundwater, we learned several important lessons regarding the extraction and analysis of soil samples. The highly heterogeneous nature of soils can lead to a high degree of variability in the amount of explosives material found in the extract. Also, by using a strongly polar solvent, like acetone, to perform an extraction, a wide variety of other materials will be contained in the sample that may cause anomalies during analysis. The nature of these matrix-related effects are not specifically known, but they do appear to be ubiquitous in soils collected from many different sites. In several cases, the HPLC analysis showed high levels of cross-reacting species, further emphasizing the importance of a complete site characterization prior to implementing any routine monitoring program. As with the groundwater, these effects can be mitigated by further treatment of the acetone extract using SPE protocols. The additional work required to perform the SPE adds significantly to the time and cost of sample preparation. However, samples prepared using SPE provide improved accuracy and precision of the assay.

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## **Appendix A**

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## **Appendix B**

### **Data Archiving and Demonstration Plan(s)**

This section includes the summary of all analyzes performed during the demonstration and validation of the NRL Environmental Immunosensors. The actual raw data is archived at NRL in the Center for Bio/Molecular Science and Engineering (CBMSE). The data along with the demonstration plans are stored as hard copies and in electronic formats. Copies of the demonstration plans or the raw data are available from Lisa Shriver-Lake or Anne Kusterbeck at CBMSE. The address, phone, and email information can be found in Appendix A.

**Appendix C**  
**U.S. EPA SW846 Method 8330**

Table 1: Fiber Optic Biosensor/Continuous Flow Immunosensor Comparison	
<b>FOB</b>  Competition Immunoassay 4 simultaneous assays 8-16 min/assay Cone penetrometer monitoring	<b>CFI</b>  Displacement Immunoassay Sequential assays 2 min/assay Intermittent on-line monitoring
Rapid Simple set-up Field portable Field tested TNT and RDX assay	

Table 2: Fiber Optic Biosensor Field Standards at SUBASE Bangor						
Sample	RDX			TNT		
	NRL Analyte 2000	QST Method 8330	RPD	NRL Analyte 2000	QST Method 8330	RPD
FLS-1 (1 ppb TNT)	----	----	----	$2 \pm 4$	1	66
FLS-2 (10 ppb TNT)	----	----	----	$8 \pm 4$	10	-22
FLS-3 (100 ppb TNT)	----	----	----	$38 \pm 19$	91	-82
FLS-4 (1000 ppb TNT)	----	----	----	>200	960	ADL
FLS-5 (5000 ppb TNT)	----	----	----	>200	5230	ADL
FLS-6 (1 ppb RDX)	$3 \pm 7$	1	93	----	----	----
FLS-7 (10 ppb RDX)	$11 \pm 4$	9	20	----	----	----
FLS-8 (100 ppb RDX)	$95 \pm 41$	97	-2	----	----	----
FLS-9 (1000 ppb RDX)	>100	1110	ADL	----	----	----
FLS-10 (5000 ppb RDX)	>100	5220	ADL	----	----	----

ADL - Above Detection Limit

<b>Table 3: Fiber Optic Biosensor on SUBASE Bangor Samples</b>						
<b>Sample</b>	<b>RDX (ppb)</b>			<b>TNT (ppb)</b>		
	<b>NRL Analyte 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>	<b>NRL Analyte 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>
INF1 <sup>+</sup>	29 ± 11	43	-39	BDL	2	BDL
INF2	>200	455	ADL	BDL	2	BDL
EW2	169 ± 185	356	-71	16 ± 11	24	-40
EW3 <sup>++</sup>	33 ± 6	50	-41	16 ± 19	5	105
EW4 <sup>+</sup>	27 ± 13	3	160	13 ± 11	0.1	198
EW5 <sup>+</sup>	15 ± 2	19	-24	BDL	0.1	BDL
EW6 <sup>+</sup>	40 ± 7	41	-2	BDL	BDL	BDL
EW7 <sup>++</sup>	106 ± 113	74	36	19 ± 10	20	-5
EW8	404 ± 453	562	-33	7 ± 14	BDL	BDL
EW9 <sup>+</sup>	10 ± 10	4	97	10 ± 13	BDL	BDL
EW10 <sup>+</sup>	299 ± 265	92	106	BDL	BDL	BDL

<sup>+</sup> Dilution performed to determine RDX values

<sup>\*</sup> Dilution performed to determine TNT values

BDL - Below detection limit

ADL - Above detection limit

Table 4: Fiber Optic Biosensor on Umatilla Army Depot Samples						
Sample	RDX (ppb)			TNT (ppb)		
	NRL's Analyte 2000	QST Method 8330	RPD	NRL's Analyte 2000	QST Method 8330	RPD
WO22*	14 ± 15	14	0	12 ± 13	0.02	BDL
EW-1 <sup>+</sup>	14 ± 4	9	43	>100	126	ADL
WO-24 <sup>+</sup>	9 ± 5	9	0	19 ± 11	BDL	BDL
EW-4 <sup>+</sup>	92 ± 94	20	129	BDL	0.45	BDL
4-114	8 ± 9	16	-67	58 ± 43	94	-47
4-7 <sup>+</sup>	15 ± 4	13	14	12 ± 12	BDL	BDL
SB-3	9 ± 10	14	-43	BDL	BDL	BDL
4-24	77 ± 18	39	66	BDL	BDL	BDL
4-112*	21 ± 6	15	33	37 ± 9	16	79
4-102 <sup>++</sup>	31 ± 7	40	-25	18 ± 4	37	-69
EW-3 <sup>++</sup>	BDL	2	BDL	17 ± 16	9	66
4-117 <sup>+</sup>	22 ± 11	21	5	59 ± 74	BDL	BDL
4-3 <sup>+</sup>	17 ± 4	13	27	BDL	0.1	BDL
4-111 <sup>+</sup>	BDL	BDL	BDL	76 ± 20	94	-21
4-25	27 ± 9	21	25	9 ± 8	BDL	BDL
WO-21 <sup>+</sup>	28 ± 6	39	-33	BDL	BDL	BDL
009 <sup>++</sup>	9 ± 6	4	77	28 ± 11	23	18
4-113*	9 ± 14	9	0	BDL	1	BDL
Combine 1 <sup>++</sup>	60 ± 12	118	-65	37 ± 26	3	172
Combine 2 <sup>++</sup>	72 ± 37	109	-41	67 ± 19	3	185
4-114D <sup>++</sup>	11 ± 11	0.3	188	56 ± 15	2	187

<sup>+</sup> Dilution performed to determine RDX values

<sup>\*</sup> Dilution performed to determine TNT values

BDL - Below detection limit

ADL - Above detection limit

<b>Table 5: Fiber Optic Biosensor on NSWC Crane Samples</b>			
<b>Sample</b>	<b>RDX (ppb)</b>		
	<b>NRL Analyte 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>
Spring	36 ± 19	119	-107
03C03P2*	40 ± 9	68	-52
03C04	BDL	BDL	BDL
10C55P2	12 ± 9	51	-124
10C55	84 ± 44	184	-75
10C57	BDL	BDL	BDL
03C08AP2	57 ± 32	126	-75
03C10	50 ± 25	121	-83
03-34	BDL	41	BDL
10-07	13 ± 6	29	-76
10-08	BDL	24	BDL
10-17	9 ± 11	35	-118
10C37	BDL	BDL	BDL
03C09P2	44 ± 9	146	-107

\* Dilution performed to determine RDX values

BDL -Below Detection Limit

<b>Table 6: Fiber Optic Biosensor on Soil Extract Samples</b>						
<b>Sample</b>	<b>RDX (µg/L)</b>			<b>TNT (µg/L)</b>		
	<b>NRL Analyte 2000</b>	<b>Method 8330</b>	<b>RPD</b>	<b>NRL Analyte 2000</b>	<b>Method 8330</b>	<b>RPD</b>
<b>TJ001</b>	1117 ± 113	BDL	BDL	BDL	BDL	BDL
<b>TJ002</b>	430 ± 74	352	20	352 ± 179	551	-44
<b>TJ003</b>	BDL	209	BDL	850717± 294655	915965	-7
<b>TJ004</b>	BDL	407	BDL	41807 ± 6576	49054	-16
<b>TJ005</b>	864 ± 70	50456	-193	102371 ± 11268	1205	195
<b>TJ006</b>	175748 ± 53072	147985	17	29441 ± 4472	82118	-94
<b>TJ007</b>	7248 ± 2867	8633	-17	98560 ± 16816	251548	-87
<b>TJ008</b>	115540 ± 10224	138500	-18	919 ± 58	BDL	BDL
<b>TJ009</b>	548 ± 40	526	4	135 ± 32	BDL	BDL
<b>TJ010</b>	2348 ± 408	2818	-18	3260 ± 268	434	153
<b>G51-L1-A</b>	2106 ± 132	2203	-5	907 ± 174	2660	-98
<b>G16-L2-A</b>	17527 ± 3326	14850	17	3278 ± 1376	12797	-118
<b>G55-X-A</b>	195637 ± 24609	135885	36	45820 ± 28643	231011	-134
<b>G18-L3-A</b>	8180 ± 2162	10259	-23	1103 ± 666	3698	-108
<b>G18-L1-A</b>	53880 ± 2114	19492	94	8419 ± 1986	23482	-94

BDL - Below detection limit

Table 7: Fiber Optic Biosensor on Soil Samples						
Sample	RDX (mg/kg)			TNT (mg/kg)		
	NRL Analyte 2000	Method 8330*	RPD	NRL Analyte 2000	Method 8330*	RPD
<b>TJ001</b>	8.0 ± 0.8	0.6	174	BDL	0.1	BDL
<b>TJ002</b>	3.1 ± 0.5	2.6	17	2.5 ± 1.3	4.4	-54
<b>TJ003</b>	BDL	4.4	BDL	6082.6 ± 2106.8	>750	
<b>TJ004</b>	BDL	BDL	BDL	298.9 ± 47.0	2318.0	-154
<b>TJ005</b>	6.2 ± 0.5	3.7	50	732.0 ± 80.6	6.3	197
<b>TJ006</b>	1256.6 ± 379.5	1247.0	1	210.5 ± 32.0	375.0	-56
<b>TJ007</b>	51.8 ± 20.5	127.0	-84	704.7 ± 120.2	1914.0	-92
<b>TJ008</b>	824.7 ± 73.0	986.0	-18	6.6 ± 0.4	4.4	39
<b>TJ009</b>	3.9 ± 0.3	3.6	8	1.0 ± 0.2	BDL	BDL
<b>TJ010</b>	16.8 ± 2.9	19.0	-12	23.3 ± 1.9	2.0	168

\*Values from T. Jenkins, CRREL

BDL - Below detection limit

<b>Table 8: Fiber Optic Biosensor False Positives/False Negative</b>		
<b>Sample</b>	<b>TNT</b> MDL= (5 ppb)	<b>RDX</b> MDL= (5 ppb)
10 ppb RDX (20 replicates)	----	0% false negative
2.5 ppb RDX (20 replicates)	----	42% false positive
10 ppb TNT (20 replicates)	0% false negative	----
2.5 ppb TNT (20 replicates)	62% false positive	----

<b>Table 9: Fiber Optic Biosensor Cross-Reactivity of Immobilized Anti-RDX and Anti-TNT Antibodies</b>				
<u>Sample</u>	<u>50% Inhibition (IC<sub>50</sub>) µg/L</u>		<u>Limit of Detection µg/L</u>	
	RDX	TNT	RDX	TNT
<b>RDX</b>	33	> 1000	5	> 1000
<b>HMX</b>	> 1000	> 1000	100	> 1000
<b>TNT</b>	> 1000	46	> 1000	5
<b>1,3,5-Trinitrobenzene</b>	> 1000	500	1000	10
<b>2-Amino-4,6-Dinitrotoluene</b>	> 1000	1500	> 1000	50
<b>2,4-Dinitrotoluene</b>	> 1000	> 1500	> 1000	50-100
<b>Tetryl</b>	> 1000	> 1500	1000	150
<b>1,3-Dinitroglycerin</b>	> 1000	> 1000	1000	250
<b>1,2-Dinitroglycerin</b>	> 1000	> 1000	> 1000	350
<b>4-Amino-2,6-Dinitrotoluene</b>	> 1000	> 1500	1000	500
<b>Dinitroethylene glycol</b>	> 1000	> 1000	1000	500
<b>1,3- Dinitrobenzene</b>	> 1000	> 1500	1000	750
<b>Trinitroglycerin</b>	> 1000	> 1000	1000	> 1000
<b>2,6-Dinitrotoluene</b>	> 1000	> 1500	> 1000	1500
<b>Nitrobenzene</b>	> 1000	> 1500	> 1000	> 1500
<b>2-Nitrotoluene</b>	> 1000	> 1500	> 1000	> 1500
<b>3-Nitrotoluene</b>	> 1000	> 1500	> 1000	> 1500
<b>4-Nitrotoluene</b>	> 1000	> 1500	> 1000	> 1500

Limit of Detection: lowest concentration to give more than 9% inhibition of the reference signal

IC<sub>50</sub>: concentration that gives 50% inhibition of the reference signal

Table 11: Matrix Effects on TNT Fiber Optic Biosensor Assay				
Spike	Bias	Precision	MDL (ppb)	RQL
<b>Umatilla Army Depot</b>				
25 ppb TNT	77	12	4	16
250 ppb TNT	115	7	9	36
<b>SUBASE Bangor</b>				
25 ppb TNT	54	31	10	40
250 ppb TNT	77	12	11	44
<b>LAAP</b>				
25 ppb TNT	76	8	2	8
250 ppb TNT	97	8	9	36
<b>Distilled Water</b>				
25 ppb TNT	50	22	6	24
250 ppb TNT	91	11	12	48

Table 10: Matrix Effects on RDX Fiber Optic Biosensor Assay				
Spike	Bias	Precision	MDL (ppb)	RQL (ppb)
<b>Umatilla Army Depot</b>				
20 ppb RDX	38	41	10	40
75 ppb RDX	50	7	8	32
<b>Crane NSWC</b>				
20 ppb RDX	9	92	2	8
75 ppb RDX	87	10	9	36
<b>LAAP</b>				
20 ppb RDX	60	41	14	56
75 ppb RDX	83	6	3	12
<b>Distilled Water</b>				
20 ppb RDX	59	38	13	52
75 ppb RDX	90	9	8	32

Table 12: FAST 2000 Field Standards at SUBASE Bangor						
Sample	RDX			TNT		
	NRL FAST 2000	QST Method 8330	RPD	NRL FAST 2000	QST Method 8330	RPD
FLS-1	----	----	----	$1 \pm 0.1$	1	0
FLS-2	----	----	----	$15 \pm 25$	8	61
FLS-3	----	----	----	$105 \pm 53$	91	14
FLS-4	----	----	----	$965 \pm 1102$	960	1
FLS-5	----	----	----	$4097 \pm 1718$	5230	-24
FLS-6	$1 \pm 0.3$	1	0	----	----	----
FLS-7	$8 \pm 2$	9	-12	----	----	----
FLS-8	$113 \pm 8$	97	15	----	----	----
FLS-9	$822 \pm 77$	1110	-30	----	----	----
FLS-10	$3980 \pm 390$	5220	-27	----	----	----

<b>Table 13: FAST 2000 on SUBASE Bangor Samples</b>						
<b>Sample</b>	<b>RDX</b>			<b>TNT</b>		
	<b>NRL FAST 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>	<b>NRL FAST 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>
EW-2	124 ± 9	356	-97	49 ± 9	24	68
EW-3	77 ± 8	496	-146	168 ± 36	263	-44
EW-4	64 ± 29	261	-121	57 ± 20	0.1	200
EW-5	345 ± 55	186	59	13 ± 6	0.1	198
EW-6	315 ± 204	419	-28	45 ± 18	BDL	BDL
EW-7	68 ± 10	147	-74	1608 ± 304	977	49
EW-8	579 ± 100	562	3	79 ± 15	0.1	200
EW-9	799 ± 383	700	13	690 ± 428	BDL	BDL
EW-10	478 ± 112	922	-63	39 ± 22	BDL	BDL
INF 1	114 ± 41	429	-116	16 ± 3	2	158
BET 1	25 ± 16	7	115	BDL	BDL	BDL
BET 2	10 ± 3	BDL	BDL	BDL	BDL	BDL
EFF	BDL	BDL	BDL	91±12	BDL	BDL

BDL - Below detection limit

<b>Table 14: FAST 2000 on Umatilla Army Depot Samples</b>						
<b>Sample</b>	<b>RDX</b>			<b>TNT</b>		
	<b>NRL FAST 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>	<b>NRL FAST 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>
4_3	61 ± 8	133	-37	BDL	BDL	BDL
4_7	88 ± 31	132	-40	33 ± 19	BDL	BDL
4_24	53 ± 18	39	30	BDL	BDL	BDL
4_25	BDL	21	BDL	32 ± 7	BDL	BDL
4_102	121 ± 24	402	-107	14 ± 3	367	-185
4_111	BDL	19	BDL	BDL	94	BDL
4_112	39 ± 26	15	87	191 ± 18	164	15
4_113	BDL	9	BDL	BDL	63	BDL
4_114	BDL	132	BDL	BDL	94	BDL
4_114D	BDL	16	BDL	56 ± 11	94	-51
4_117	165 ± 53	209	-24	BDL	BDL	BDL
9	77 ± 7	189	-84	958 ± 354	1160	-19
SB-3	BDL	14	BDL	48 ± 18	BDL	BDL
WO-21	163 ± 14	389	-82	BDL	BDL	BDL
WO-22	BDL	14	BDL	BDL	0.2	BDL
WO-24	233 ± 22	470	-67	BDL	BDL	BDL
EW-1	43 ± 28	450	-165	8 ± 4	126	-176
EW-3	149 ± 51	112	28	457	846	-60
EW-4	902 ± 53	1020	-12	56 ± 31	0.5	197
Comb-1	607 ± 106	1180	-64	73 ± 28	138	-53
Comb-2	990 ± 101	1090	-10	190 ± 30	133	35

BDL- Below detection limit

<b>Table 15: FAST 2000 on NSWCrane Samples</b>						
<b>Sample</b>	<b>RDX</b>			<b>TNT</b>		
	<b>NRL FAST 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>	<b>NRL FAST 2000</b>	<b>QST Method 8330</b>	<b>RPD</b>
Spring	174 ± 78	119	38	115 ± 16	3	189
03C03	504 ± 35	678	-29	BDL	4	BDL
03C04	BDL	BDL	BDL	BDL	BDL	BDL
03C08	11 ± 5	126	-168	14 ± 9	BDL	BDL
03C09	483 ± 62	146	120	BDL	BDL	*
03C09P2	BDL	BDL	BDL	BDL	NA	BDL
03C10	104 ± 41	121	-15	BDL	BDL	BDL
03C12	17 ± 7	26	-40	BDL	BDL	BDL
03_34	23 ± 9	41	-56	BDL	BDL	BDL
10-07	54 ± 6	29	62	BDL	1	BDL
10-08	BDL	24	BDL	5 ± 3	1	134
10-17	32 ± 17	35	-11	7 ± 3	22	-102
10C37	BDL	BDL	BDL	BDL	BDL	BDL
10C55	184 ± 56	184	0	40 ± 12	51	23
10C55R	47 ± 18	51	-9	BDL	BDL	BDL
10C57R	66 ± 33	BDL	BDL	BDL	BDL	BDL

BDL - Below detection limit

<b>Table 16: FAST 2000 on Soil Extract Samples</b>						
<b>Sample</b>	<b>RDX (µg/L)</b>			<b>TNT (µg/L)</b>		
	<b>NRL FAST 2000</b>	<b>Method 8330</b>	<b>RPD</b>	<b>NRL FAST 2000</b>	<b>Method 8330</b>	<b>RPD</b>
<b>TJ001</b>	400 ± 64	BDL	BDL	22 ± 6	BDL	BDL
<b>TJ002</b>	530 ± 51	352	40	367 ± 113	551	-40
<b>TJ003</b>	59 ± 10	209	-112	1027286 ± 204000	915965	11
<b>TJ004</b>	110 ± 9	407	-115	481714 ± 117000	49054	163
<b>TJ005</b>	598 ± 123	50456	-195	342248 ± 115565	1205	199
<b>TJ006</b>	193400 ± 36100	147985	27	963143 ± 313000	82118	169
<b>TJ007</b>	8560 ± 920	8633	-1	183166 ± 48034	251548	-31
<b>TJ008</b>	92900 ± 6500	138500	-39	7301 ± 1016	BDL	BDL
<b>TJ009</b>	365 ± 37	526	-36	14223 ± 1047	BDL	BDL
<b>TJ010</b>	3470 ± 520	2818	21	87086 ± 25600	434	198
<b>G51-L1-A</b>	3550 ± 290	2203	47	5534 ± 1350	2660	70
<b>G16-L2-A</b>	36800 ± 3500	14850	85	27171 ± 16000	12797	72
<b>G55-X-A</b>	74400 ± 13000	135885	-58	219363 ± 66979	231011	-5
<b>G18-L3-A</b>	14355 ± 1440	10259	33	27857 ± 3300	3698	153
<b>G18-L1-A</b>	80500 ± 11400	19492	122	50614 ± 6300	23482	73

BDL -Below Detection Limit

Table 17: FAST 2000 for Soil Samples						
Sample	RDX (mg/kg)			TNT (mg/kg)		
	NRL Analyte 2000	Method 8330*	RPD	NRL Analyte 2000	Method 8330*	RPD
TJ001	2.9 ± 0.5	0.6	114	0.2 ± 0.04	0.1	104
TJ002	3.8 ± 0.4	2.6	2	2.6 ± 0.8	4.4	-51
TJ003	BDL	4.4	BDL	7345.1 ± 1458.6	>750	
TJ004	BDL	BDL	BDL	3444.3 ± 836.6	2318.0	39
TJ005	4.3 ± 0.9	3.7	-21	2447.1 ± 826.3	6.3	199
TJ006	1382.8 ± 258.1	1247.0	-25	6886.5 ± 2238.0	375.0	179
TJ007	61.2 ± 6.6	127.0	-99	1390.6 ± 1343.4	1914.0	-37
TJ008	2262.6 ± 92.8	986.0	46	52.1 ± 7.3	4.4	169
TJ009	2.6 ± 0.3	3.6	-65	101.7 ± 7.5	BDL	BDL
TJ010	24.8 ± 3.7	19.0	-9	622.7 ± 183.0	2.0	199

\*Values from T. Jenkins, CRREL

BDL - Below detection limit

<b>Table 18: FAST 2000 False Positives/False Negative in Buffer</b>		
<b>Sample</b>	<b>TNT</b> MDL=10ng/mL	<b>RDX</b> MDL= 10ng/mL
5ng/mL TNT (20 replicates)	0% positive	----
20ng/mL TNT (20 replicates)	0% negative	----
5ng/mL RDX (30 replicates)	----	0% negative
20ng/mL RDX (30 replicates)	----	0% positive

<b>Table 19: FAST 2000 Accuracy and Precision (System Flow Buffer)</b>		
<b>Sample</b>	<b>TNT/RDX</b> MDL=10ng/mL	
	Bias	Precision
50ng/mL TNT (9 replicates)	99	7
500ng/mL TNT (7 replicates)	93	14
50ng/mL RDX (7 replicates)	98	15
500ng/mL RDX (7 replicates)	99	6

<b>Table 20: Matrix Effects on RDX FAST 2000 Assay</b>				
<b>Spike</b>	<b>Bias</b>	<b>Precision</b>	<b>MDL (ppb)</b>	<b>RQL (ppb)</b>
<b>Umatilla Army Depot</b>				
50 ppb RDX	20	37	7	28
500 ppb RDX	62	11	107	427
<b>Bangor SUBBASE</b>				
50 ppb RDX	55	9	7.5	30
500 ppb RDX	96	3	53	214
<b>Volunteer, TN</b>				
50 ppb RDX	N/D	N/D	N/D	N/D
500 ppb RDX	29	59	268	1074

Table 21: Matrix Effects on TNT FAST 2000 Assay				
Spike	Bias	Precision	MDL (ppb)	RQL (ppb)
<b>Umatilla Army Depot</b>				
50 ppb TNT	130	10	20	80
500 ppb TNT	97	86	409	1634
<b>Bangor SUBBASE</b>				
50 ppb TNT	212	26	85	340
500 ppb TNT	68	63	211	842
<b>Volunteer, TN</b>				
50 ppb TNT	653	41	475	1898
500 ppb TNT	142	15	324	1295

<b>Table 22: FAST 2000 Cross-reactivity of anti-RDX and anti-TNT Antibodies</b>		
<b>Sample</b>	<b>Anti-RDX Ab Cross-reactivity (%)</b>	<b>Anti-TNT Ab (11B3) Cross-reactivity (%)</b>
RDX	100	1
2,4,6-Trinitrotoluene (TNT)	1.8	100
HMX	4.8	5
2-Nitrotoluene (NT)	1.9	9
3-Nitrotoluene	2.6	ND
4-Nitrotoluene	3.0	ND
Nitrobenzene (NB)	1.9	16
1,3-Dinitrobenzene (DNB)	2.8	ND
1,3,5- Trinitrobenzene (TNB)	3.8	600
Tetryl	0.95	38
2,4-Dinitrotoluene (DNT)	3.1	20
2,6-Dinitrotoluene	1.1	4
Trinitroglycerin	1.4	ND
2-Amino-4,6-DNT	1.3	21
4-Amino-2,6-DNT	1.8	1
1,2-Dinitroglycerin	18	ND
1,3-Dinitroglycerin	1.3	ND
Dinitro Ethylene Glycol	1.9	ND

ND - not determined

Table 23: Technology Comparison of Groundwater Explosive Analysis							
Method/Kit	Method Types and Analytes	Detection Range and Range Factor	Type of Results	Sample/Batch	Water Sample Size	Analysis Time	Skill Level
Continuous Flow Immunosensor	Immunosensor TNT, RDX, PETN	10-1000 ug/L	Quantitative	Sequential	150 uL /sample per injection.	3-4 min sample, plus 3-4 min internal standard 1 min peak analysis per sample	Medium/low
Fiber Optic Biosensor	Immunosensor TNT RDX	TNT:10-150 ug/L RDX:10-100 ug/L	Quantitative	Single up to a batch of 4	1.7 mL for 4 fiber analysis with fluidics unit	TNT: 8 min per quadruplicate sample or batch of 4 RDX: 16 min per quadruplicate sample or batch of 4 Double times to run reference analysis	Medium
CRREL	Colorimetric Ammonium Picrate/Picric Acid	AP/PA: 3.6 to 200ug/L (56X)	Quantitative	AP/PA: Single or batched	2L	20 minutes to hours to filter, faster per sample if batched; 20 minutes/sample to analyze	Medium /high
EnSys RIS	Colorimetric TNT, RDX and HMX Proposed Method 8510	TNT: 1 to 30 ug/L (30X) RDX: 5 to 150 (30X)	Quantitative	Single	2 L	20 minutes to a few hours for filtering TNT: 35 min/10 samples RDX: 50 min/sample	Medium
D-TECH	Immunoassay - ELISA TNT RDX	TNT and RDX: 5 to 45 ug/L (9X) with DETECTOR TNT and RDX: 5 to 60 ug/L (12X)	Semiquantitative (concentration range)	8 (single or batch)?	1 mL	40 minutes for 8 samples for TNT and RDX 10 to 15 minutes for single sample	Low
Ohmicron RaPID Assay	Immunoassay - ELISA Magnetic particle/tube kit TNT	TNT: 0.07 to 5 ug/L (71 X)	Quantitative	10 to 40 (batch only)	100 uL	70 minutes for 10 samples	High, initial training recommended
Method 8330	High Performance Liquid Chromatography	Direct injection: RDX : 14 ug/L TNT : 7 ug/L  Salting out and extraction: RDX: 0.84 ug/L TNT: 0.11 ug/L	Quantitative	Single	100 uL	20 min/sample If <20 ug/L need salting - out extraction ~2-3 hours/sample	high

Table 24: Technology Comparison of Soil Explosive Analysis								
Method / kit	Method type/ analytes	Detection range	Type of result	Samples/ batch	Sample size	Sample preparation time	Sample analysis time	Skill level required
Fiber Optic Biosensor	Immunoassay TNT, RDX	TNT: 0.7-21 mg/kg RDX: 0.7-14 mg/kg	quantitative	1-4	5 g	3 min shaking in 25 mL acetone, settle	TNT: 8 min per quadruplicate sample or batch of 4 RDX: 16 min per quadruplicate sample or batch of 4 Double times to run reference analysis	Medium
Continuous Flow Immunosensor	Immunoassay TNT, RDX	0.05 - 5 mg/kg	quantitative	1	5 g	3 min shaking in 25 mL acetone, settle	3-4 min sample, plus 3-4 min internal standard 1 min peak analysis per sample	Medium/ low
CRREL	Colorimetric TNT,RDX, 2,4DNT, ammonium picrate, picric acid	TNT: 1-22 mg/kg RDX: 1-20 mg/kg	quantitative	TNT: batch or single RDX: 6-7	20 g	3 min shaking in 100 mL acetone, filter	5 min/ sample	Medium
Ensys RISC	colorimetric TNT,RDX	TNT, RDX: 1-30 mg/kg	quantitative	single	10 g	3 min shaking in 50 mL acetone, 5 min to settle, filter	40 min per 10 samples	TNT: low RDX: Medium
Dtech	Immunoassay TNT,RDX	TNT:0.5-5.0 mg/kg	semi-quantitative (concentration range)	4 single or batch	3 ml ~4.5g	3 min shaking in 6.5 mL acetone, 1-10 min to settle	30 min per 1-4 samples	Low
Idetek Quantix	Immunoassay TNT	TNT; 0.25-100 mg/kg	quantitative	20-40 batch only	~4.2 g	3 min shaking in 21 mL acetone, settle	2.5-3.5 hours for 20-40 samples	Medium-High
EnviroGard	Immunoassay TNT,RDX	Plate: TNT, RDX 1-100 mg/kg Tube: TNT, RDX 0.2-15 mg/kg	Plate: quantitative Tube: semi-quantitative	Plate: 8 per batch Tube: 14 per batch	2 g	Air dry soil, 2 min shaking in 8 mL acetone, filter	Plate: 90 min for 8 samples Tube: 30 min for 14 samples	Plate: Medium-High Tube: Medium
Ohmicron RaPID Assay	Immunoassay TNT,RDX	TNT: 0.07-5 mg/kg	quantitative	5-51 batch only	10 g	1 min shaking in 20 mL methanol, 5 min to settle, filter	1 hour for 20 extractions; 45 minutes for analysis (51 samples)	Medium-High



**Table 25: Technology Cost Comparison of Groundwater Explosive Analysis**

Method/Kit	On-Going Cost	Start-Up Costs	Training
Continuous Flow Immunosensor	\$50 per coupon ~20-30 analysis per coupon	FAST 2000 \$21K unit cost.	None
Fiber Optic Biosensor	\$3-5/sample	Analyte 2000 \$18K Fluidics unit - ~\$8K	None
CRREL	\$15/sample	\$1500 for Hach spectrometer	None
EnSys RIS	\$21/sample for TNT \$25/sample for RDX \$175/day or \$450/week, \$800/month for lab station	\$1950 lab station cost	Training available. Applicable video on CRREL soil method available only
D TECH	\$32.50/sample for TNT or RDX \$300 for DTECHTOR (optional)		2 to 4 hours free on-site training
Ohmicron Rapid Assay	\$13 to \$20/sample, \$175/day,\$450/week or \$800 for first month, \$400 each additional month (rental)	\$4000 for equipment	4 hours free on-site training
Method 8330	\$200 - \$1,000/sample depending on turnaround time	n/a	n/a

<b>Table 26: Technology Cost Comparison of Soil Explosive Analysis</b>			
<b>Method / Kit</b>	<b>On-Going Costs</b>	<b>Start-Up Costs</b>	<b>Training</b>
<b>Fiber Optic Biosensor</b>		<b>FAST 2000 - \$21K</b>	<b>None</b>
<b>Continuous Flow Immunosensor</b>		<b>Analyte 2000 - \$18K Fluidics Unit - ~\$8K</b>	<b>None</b>
<b>CRREL</b>	<b>\$15/sample</b>	<b>\$1500 for Hach spectrophometer</b>	<b>Free video</b>
<b>Ensys RISC</b>	<b>TNT: \$21/sample RDX: \$25/sample</b>	<b>\$1950 for lab station</b>	<b>Available- free</b>
<b>Dtech</b>	<b>\$30/sample</b>	<b>\$300 DTECHTOR (optional)</b>	<b>2-4 hrs free training</b>
<b>Idetek Quantix</b>	<b>\$21/sample</b>	<b>\$5880 for lab station</b>	<b>1day free training</b>
<b>EnviroGard</b>	<b>Plate: \$17/sample Tube: \$20/sample</b>	<b>Plate: \$4129 for equip and small supplies Tube: \$2409 for equip. and small supplies</b>	<b>Available- free</b>
<b>Ohmicron RaPID Assay</b>	<b>\$13-20/sample</b>	<b>\$5500 for equip. purchase or rental for\$800 1<sup>st</sup> month and \$400 monthly thereafter</b>	<b>4 hrs free training</b>



Figure 1



Figure 2

## Competitive immunoassay on an optical fiber

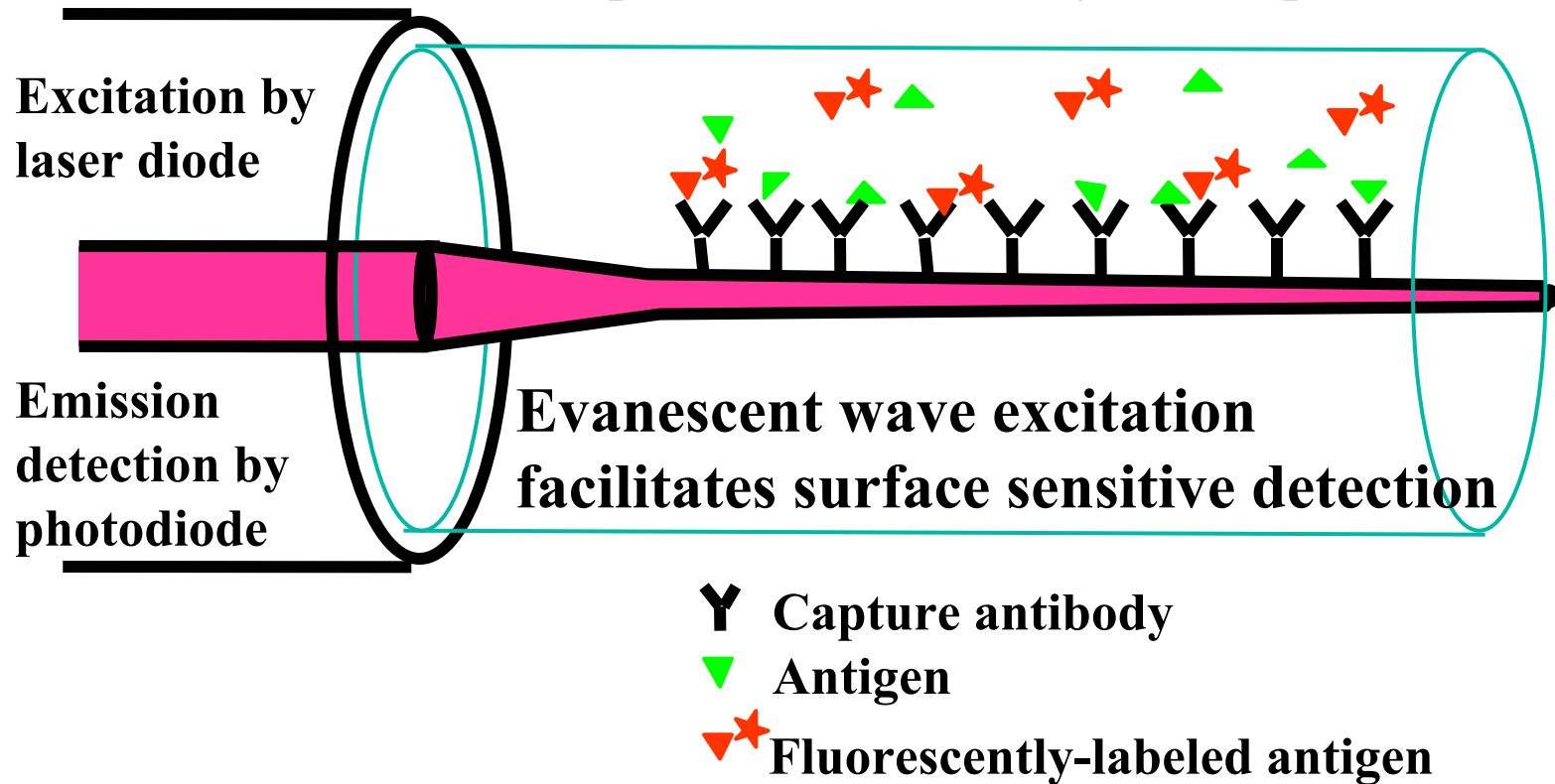


Figure 3

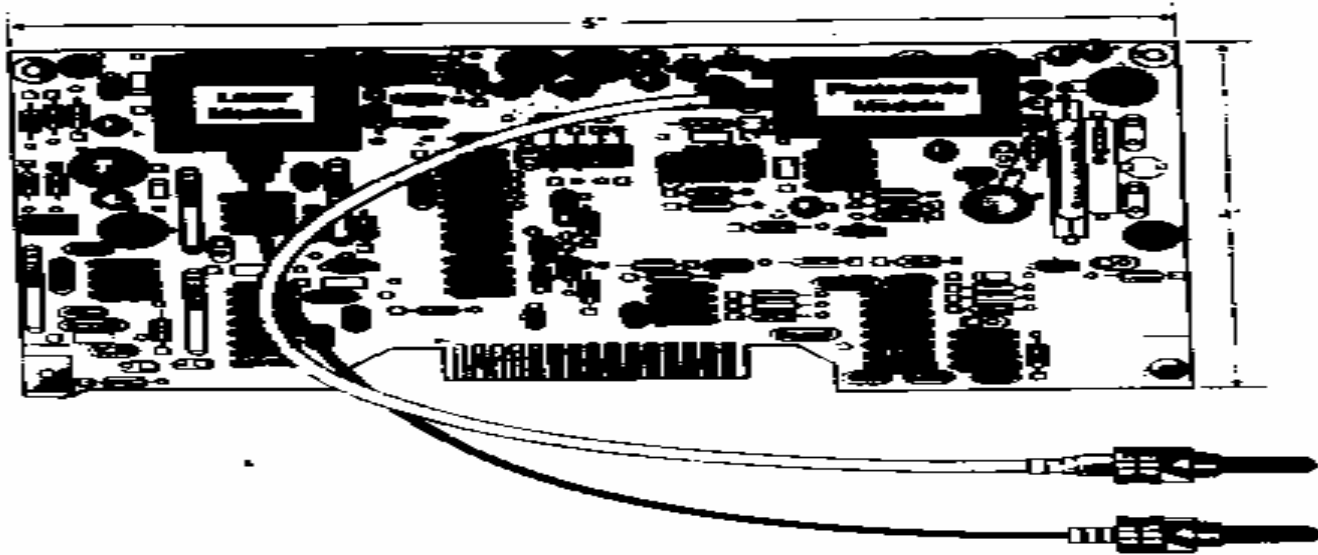


Figure 4: Daughter card from the Analyte 2000.

Figure 4

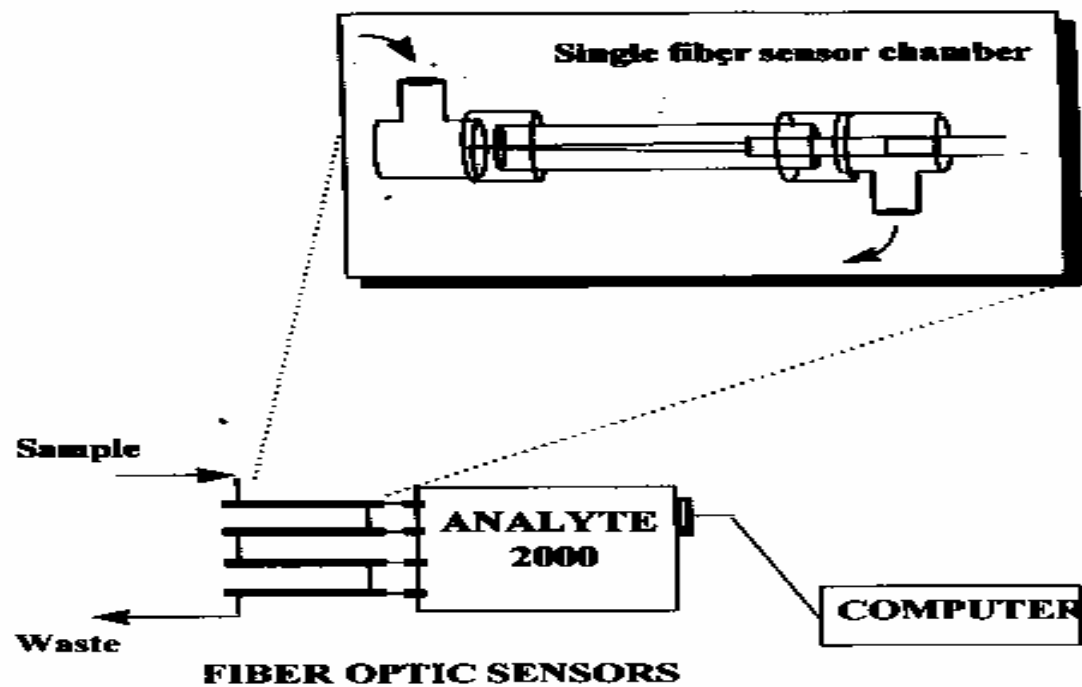


Figure 5: Capillary flow chambers in series with the Analyte 2000

Figure 5

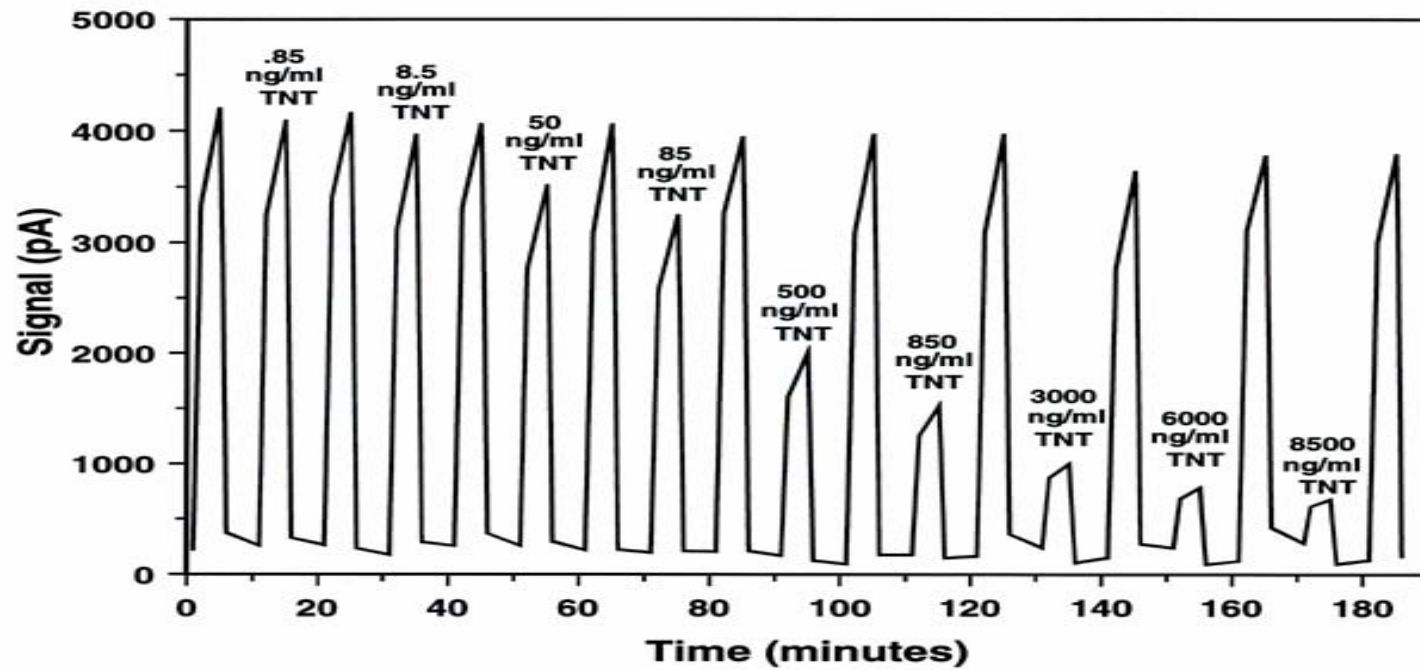


Figure 6

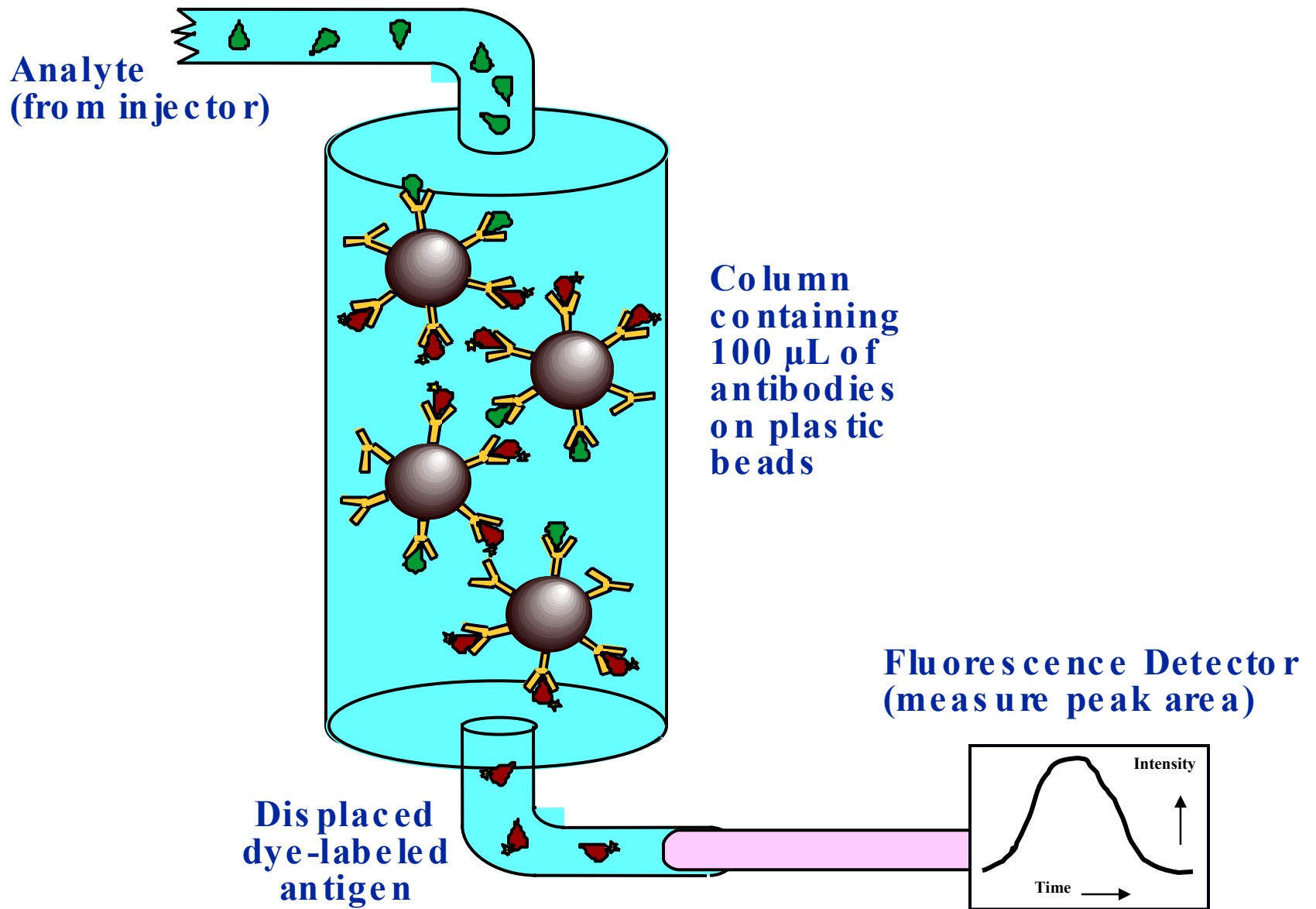
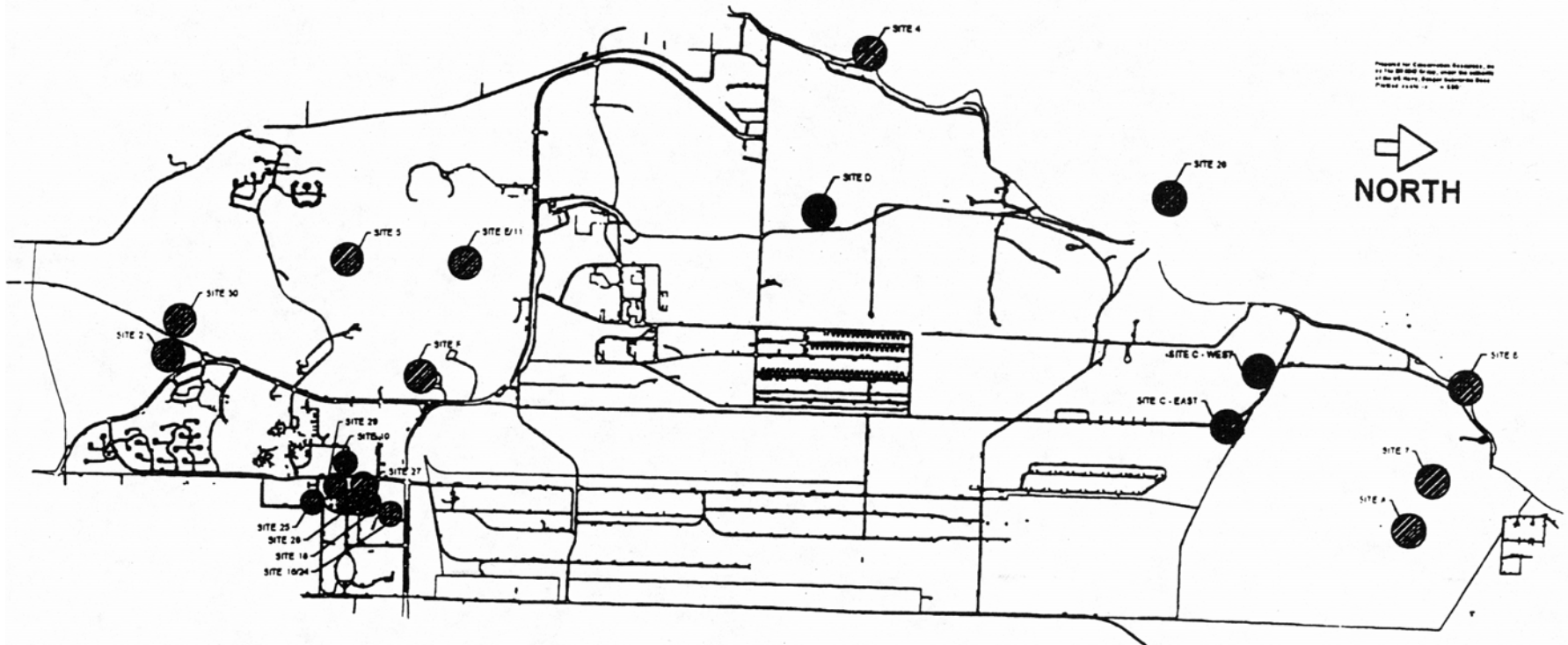


Figure 7

# Naval Submarine Base Bangor Installation Restoration Program Site Locations



OPERABLE UNIT 1  
Site A Bangor Ordnance Disposal Site

OPERABLE UNIT 2  
Site F Former Wastewater Lagoon

OPERABLE UNIT 3  
Site 16 Storage Area  
Site 24 Former Incinerator Site  
Site 25 Former Treatment Plant Outfall

OPERABLE UNIT 4  
Site C - West Bldg 7700 Fill Area  
Site C - East Ordnance Wastewater Disposal Area

OPERABLE UNIT 5  
Site 5 Former Metallurgy Lab Rubble

OPERABLE UNIT 6  
Site D Munitions Burn Area

OPERABLE UNIT 7  
Site 8 Floral Point  
Site E Old Acid Pit  
Site 2 Classification Yard  
Site 4 Carlson Spill  
Site 7 Paint Can Site  
Site 10 Pesticide Storage Quonset Hut  
Site 11 Pesticide Drum Disposal Area  
Site 18 PCB Spill Site  
Site 26 Hood Canal Sediments  
Site 30 Railroad Tracks

OPERABLE UNIT 8  
Public Works Industrial Area including  
Site 27 Bldg 1014 Steam Cleaning Pit  
Site 28 Bldg 1032 Drainage Ditch  
Site 29 Former Pesticide Rinsewater Area

Figure 8

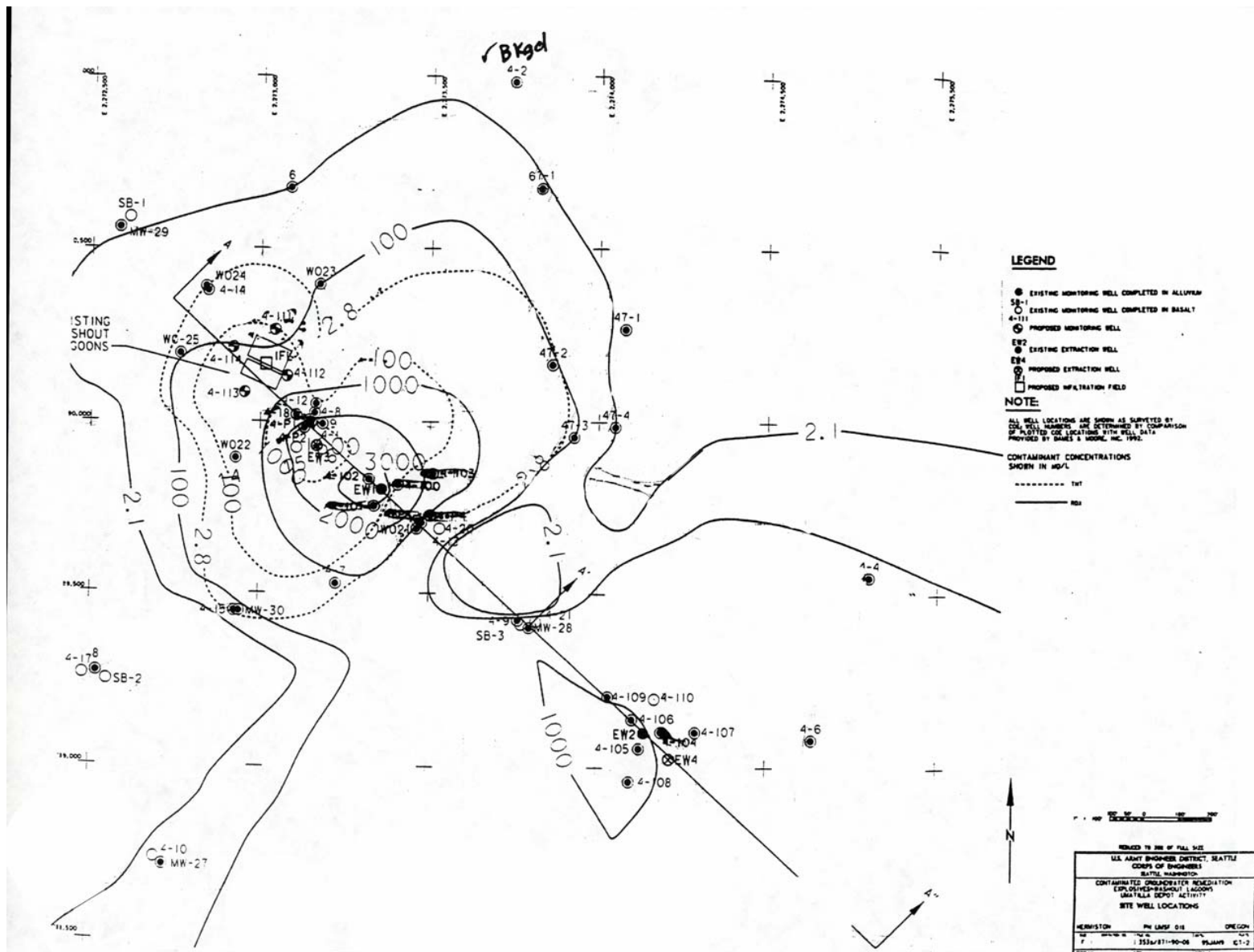


Figure 12

# Method 8330 RDX Regression Plot

## SUBASE Bangor Samples

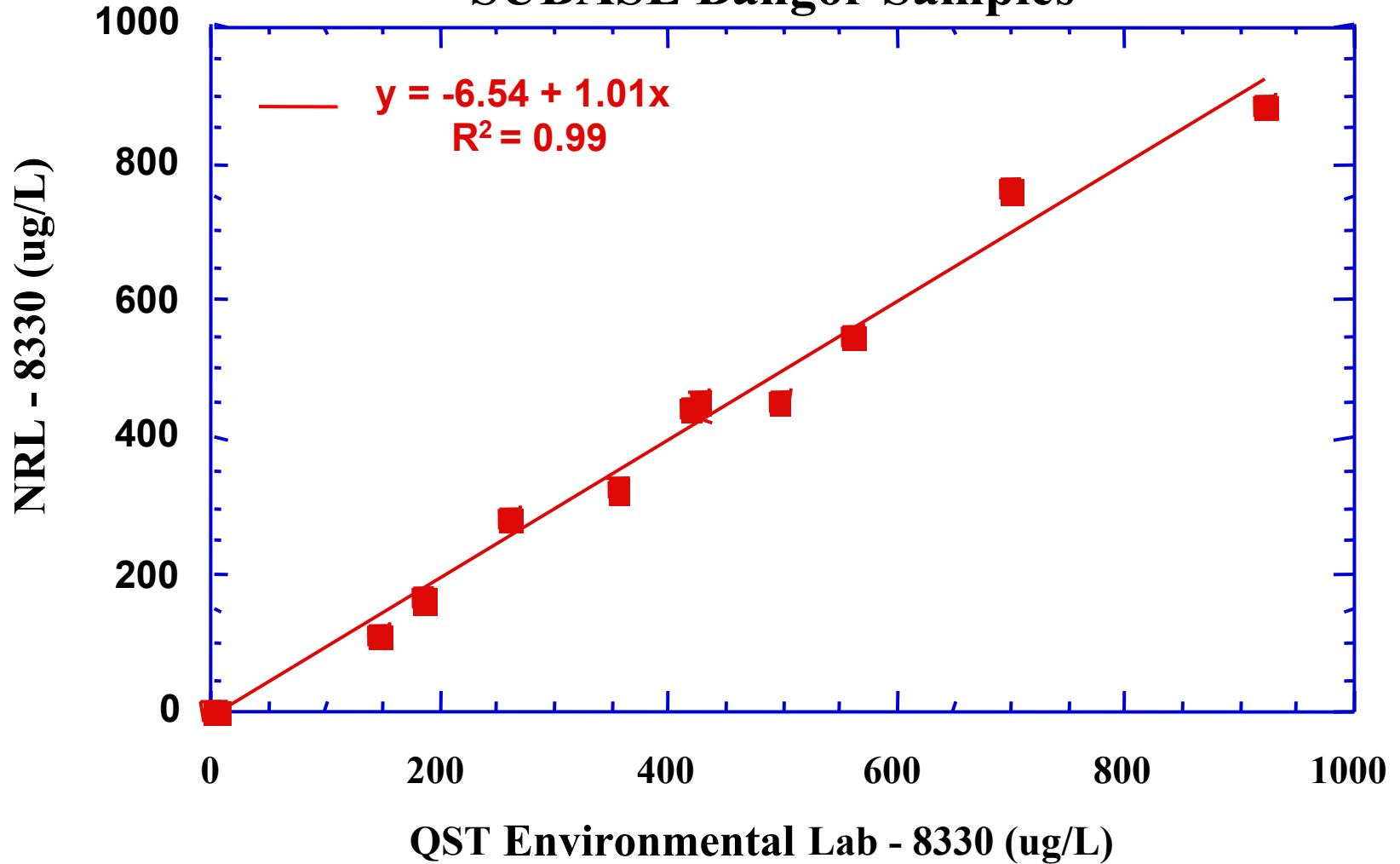


Figure 14

# TNT and RDX

## Standard Curves

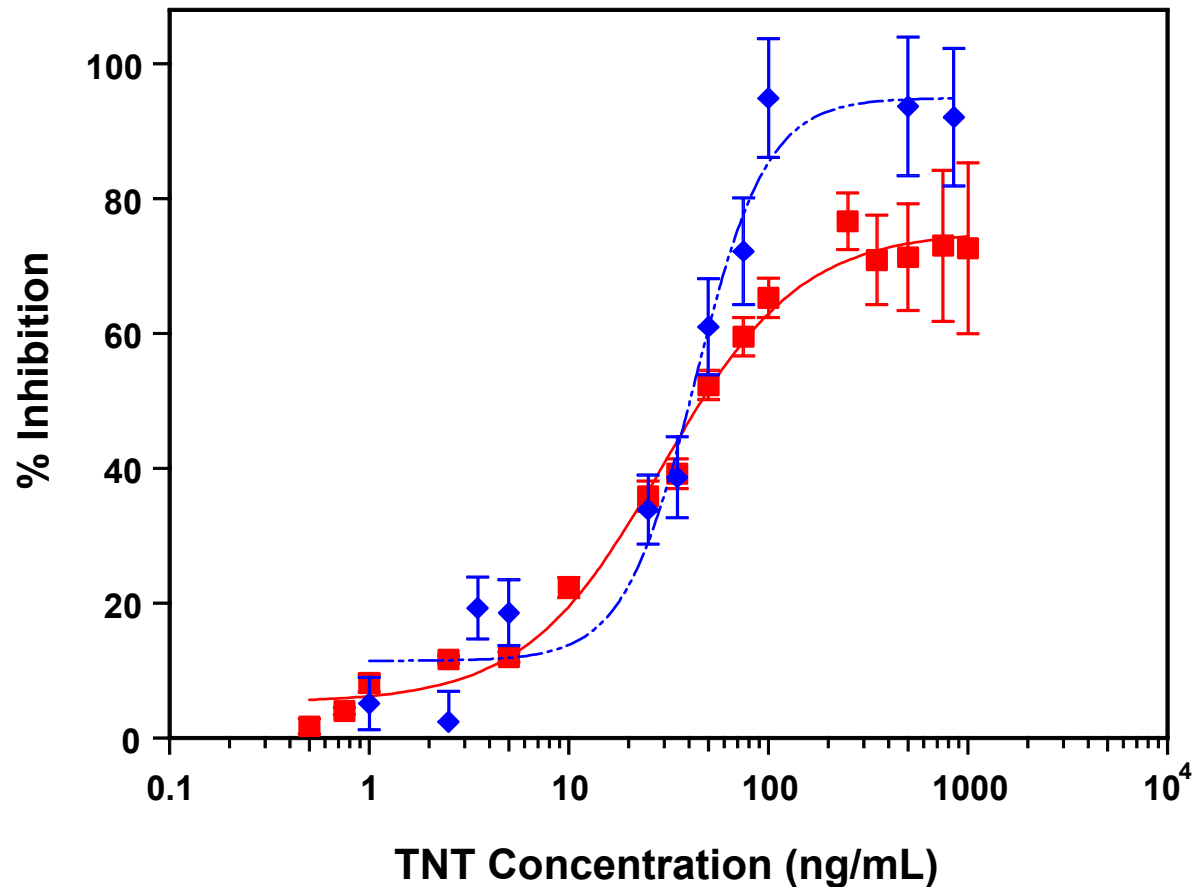


Figure 15

## RDX FOB vs. QST HPLC Bangor, WA

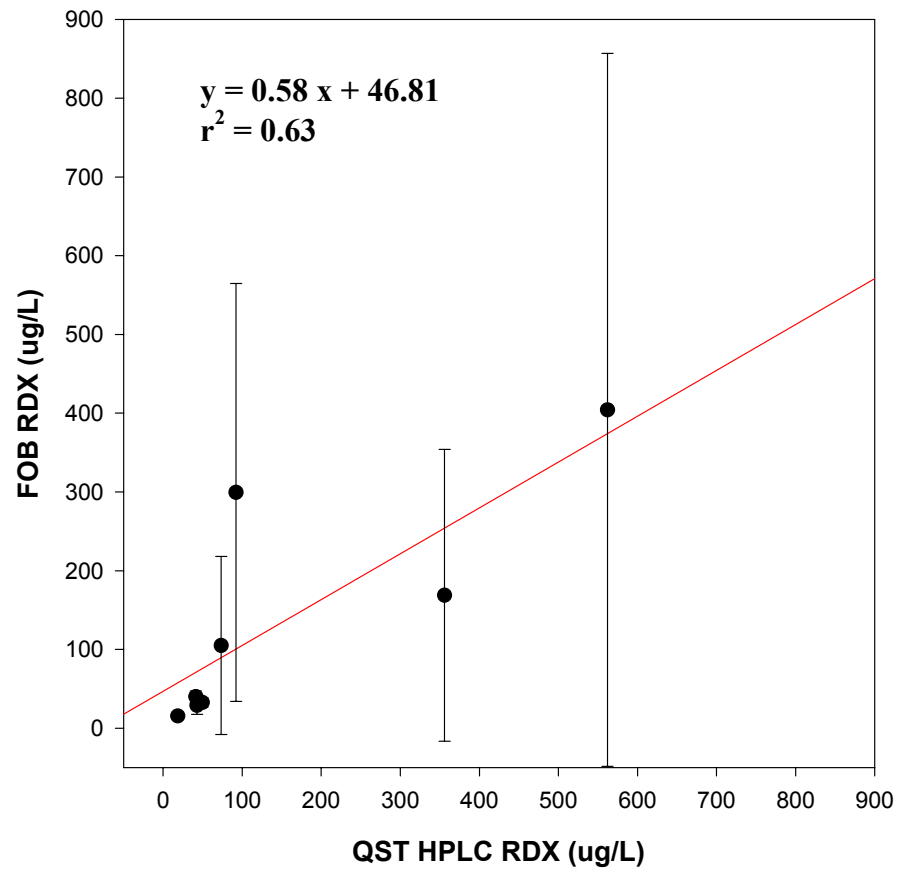


Figure 16

# TNT FOB vs. QST HPLC Bangor, WA

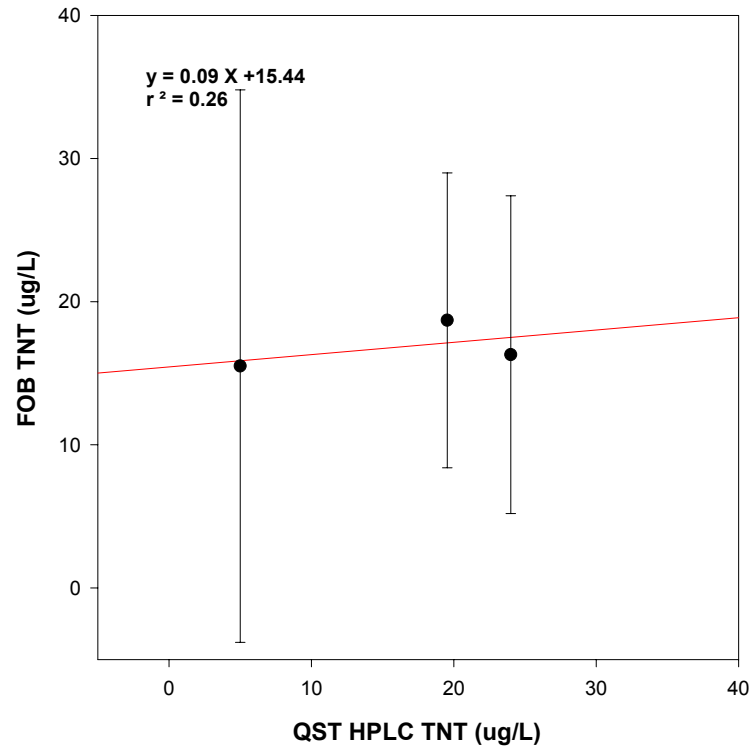


Figure 17

# RDX FOB vs. QST HPLC Umatilla, OR

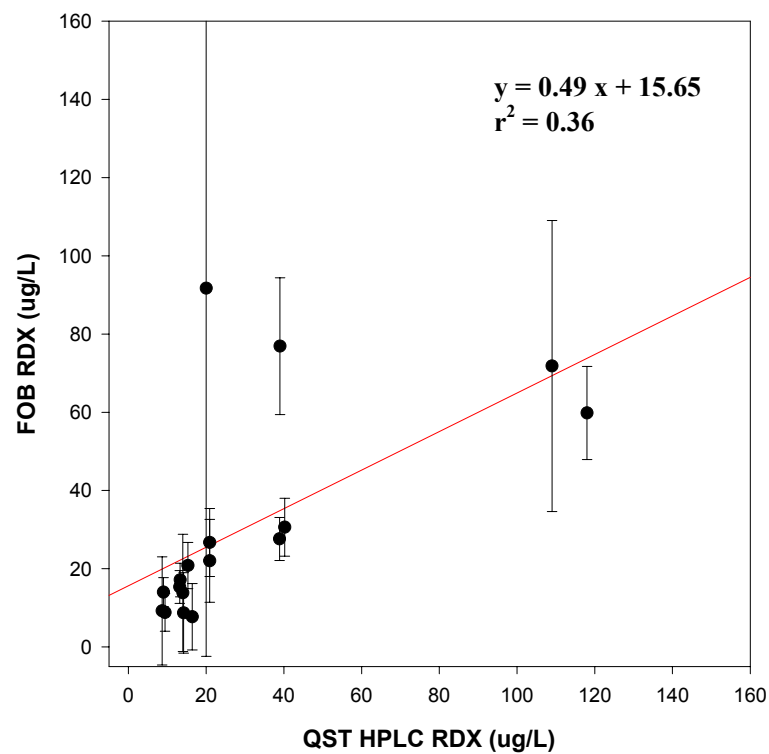


Figure 18

## TNT FOB vs. QST HPLC Umatilla, OR

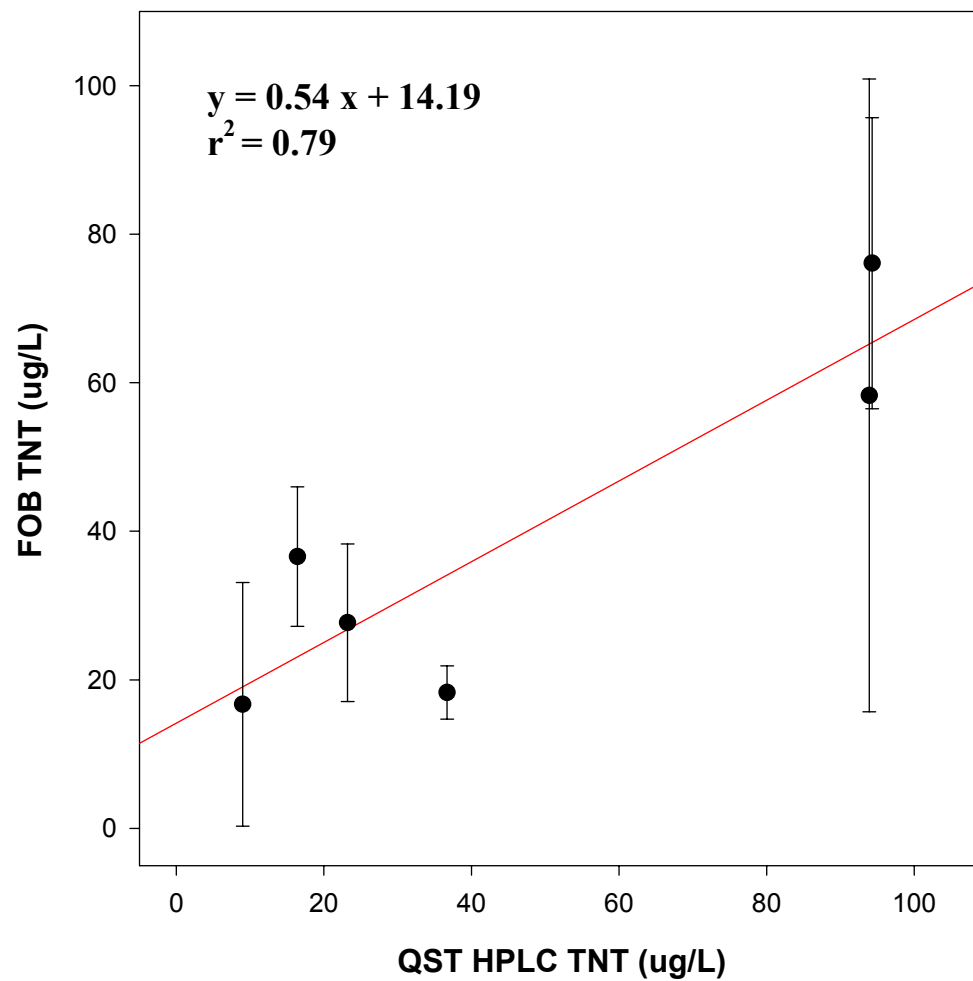


Figure 19

## RDX FOB vs. QST HPLC Crane, IN

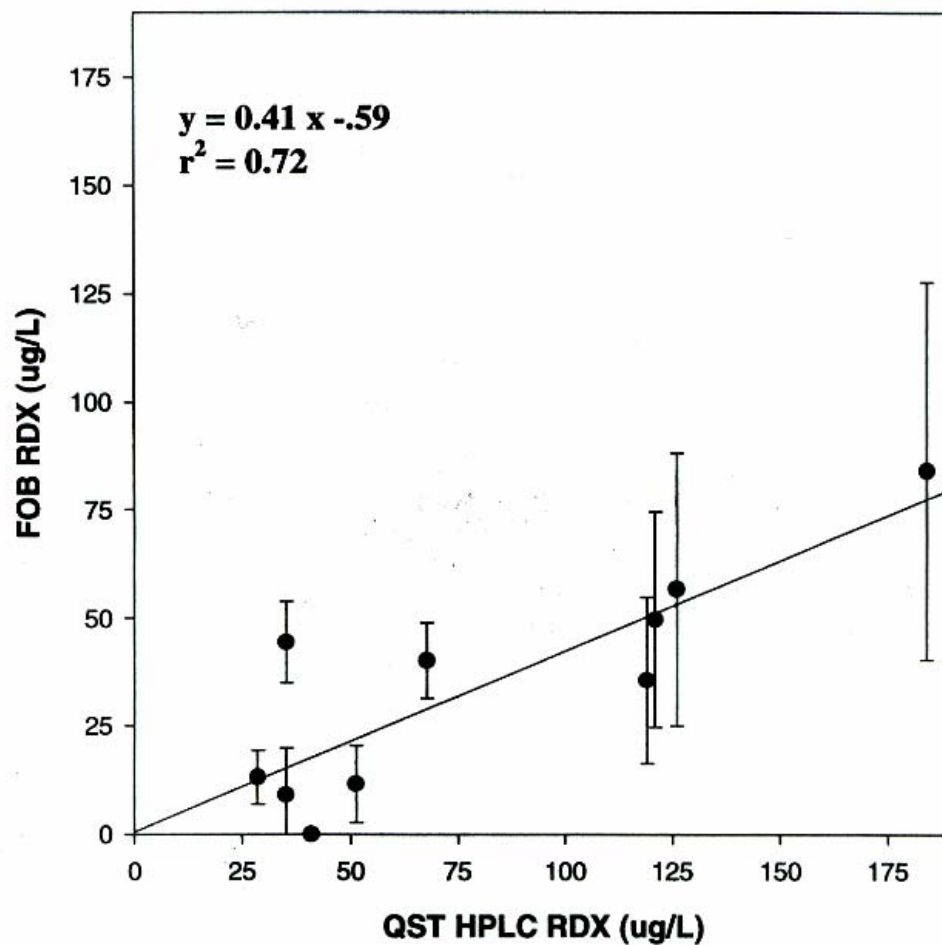
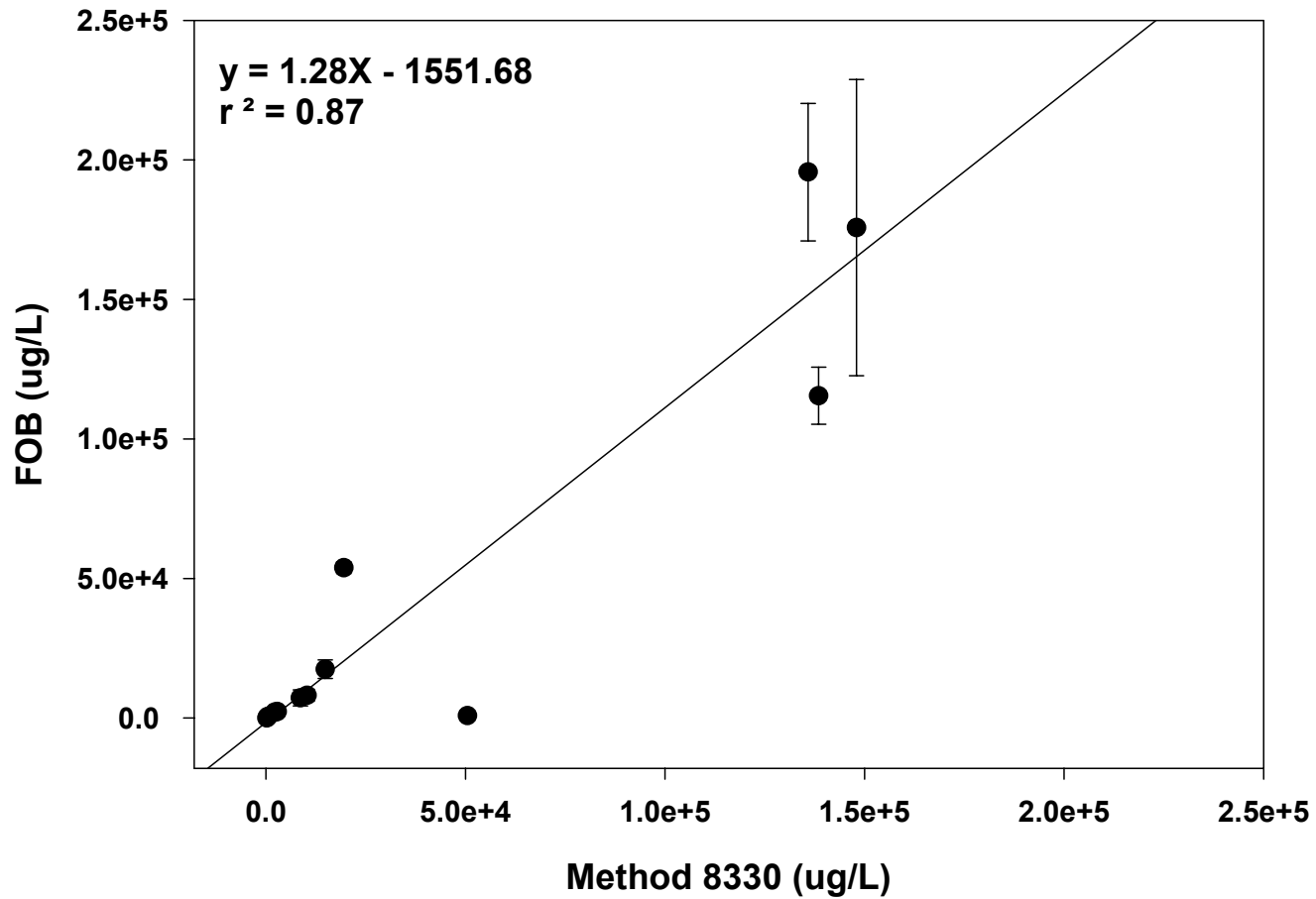


Figure 20

**RDX FOB vs Method 8330**  
**Soil extracts**



**Figure 21**

# TNT FOB vs Method 8330 Soil extracts

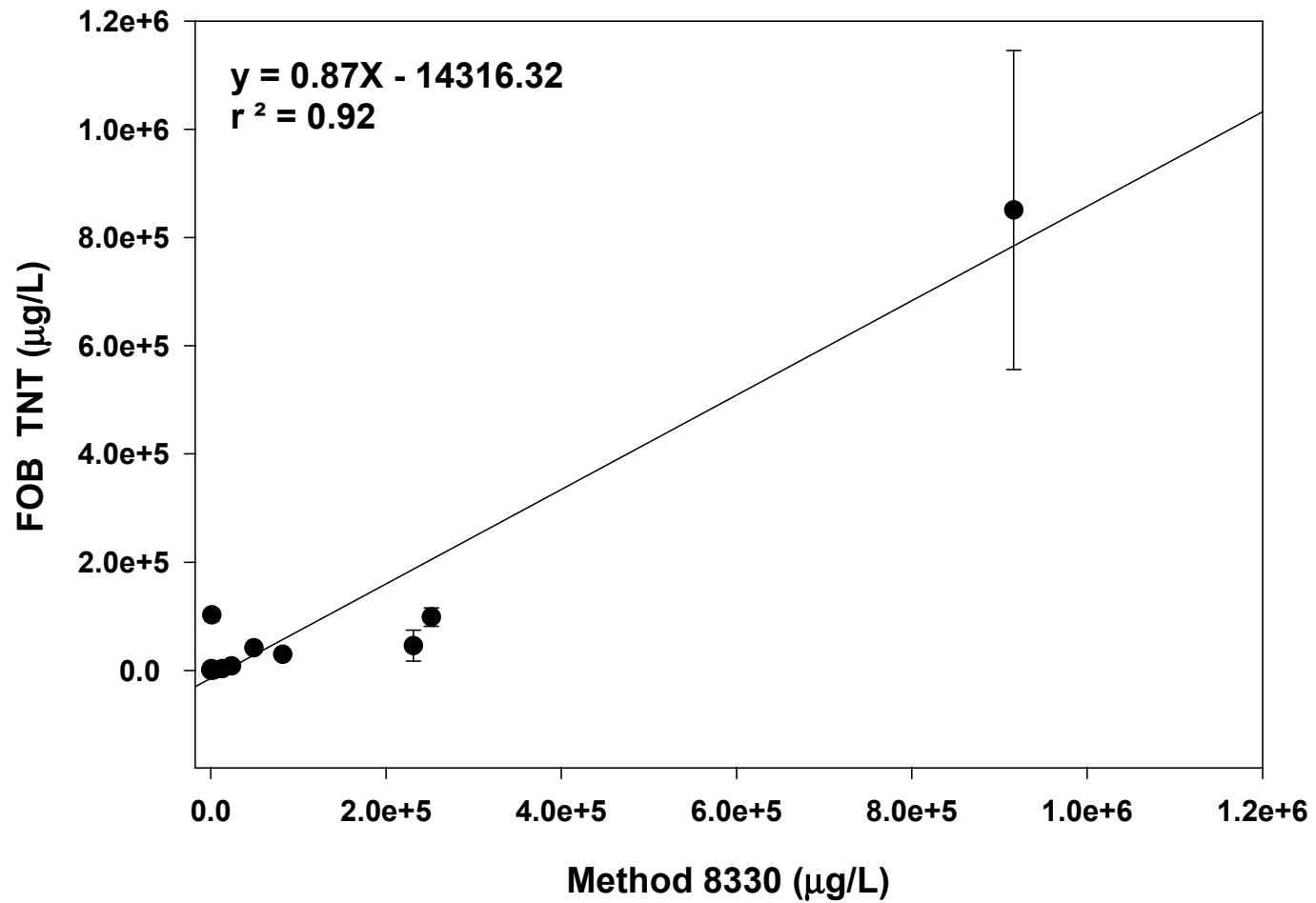
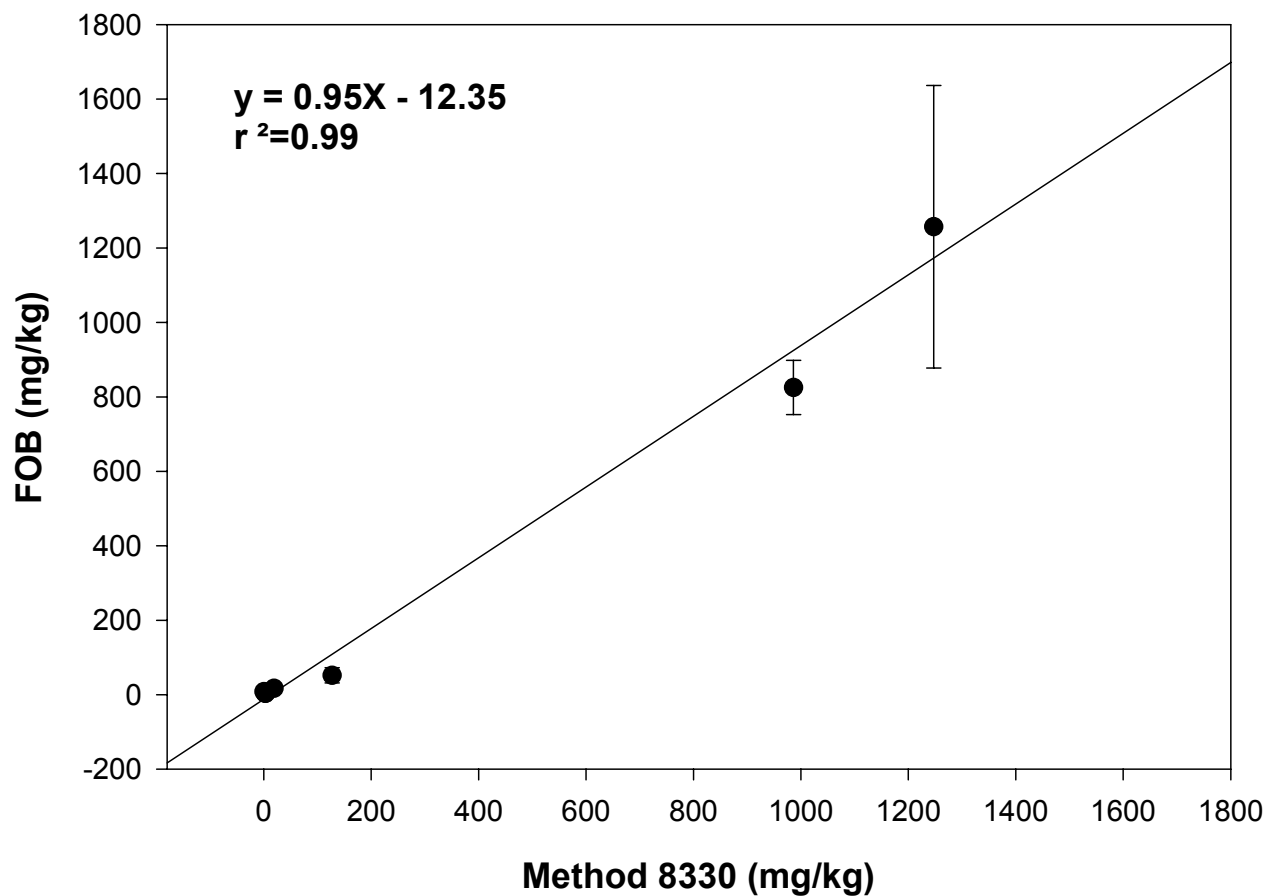


Figure 22

# **RDX FOB vs Method 8330 Soil**



**Figure 23**

# TNT FOB vs Method 8330 Soil

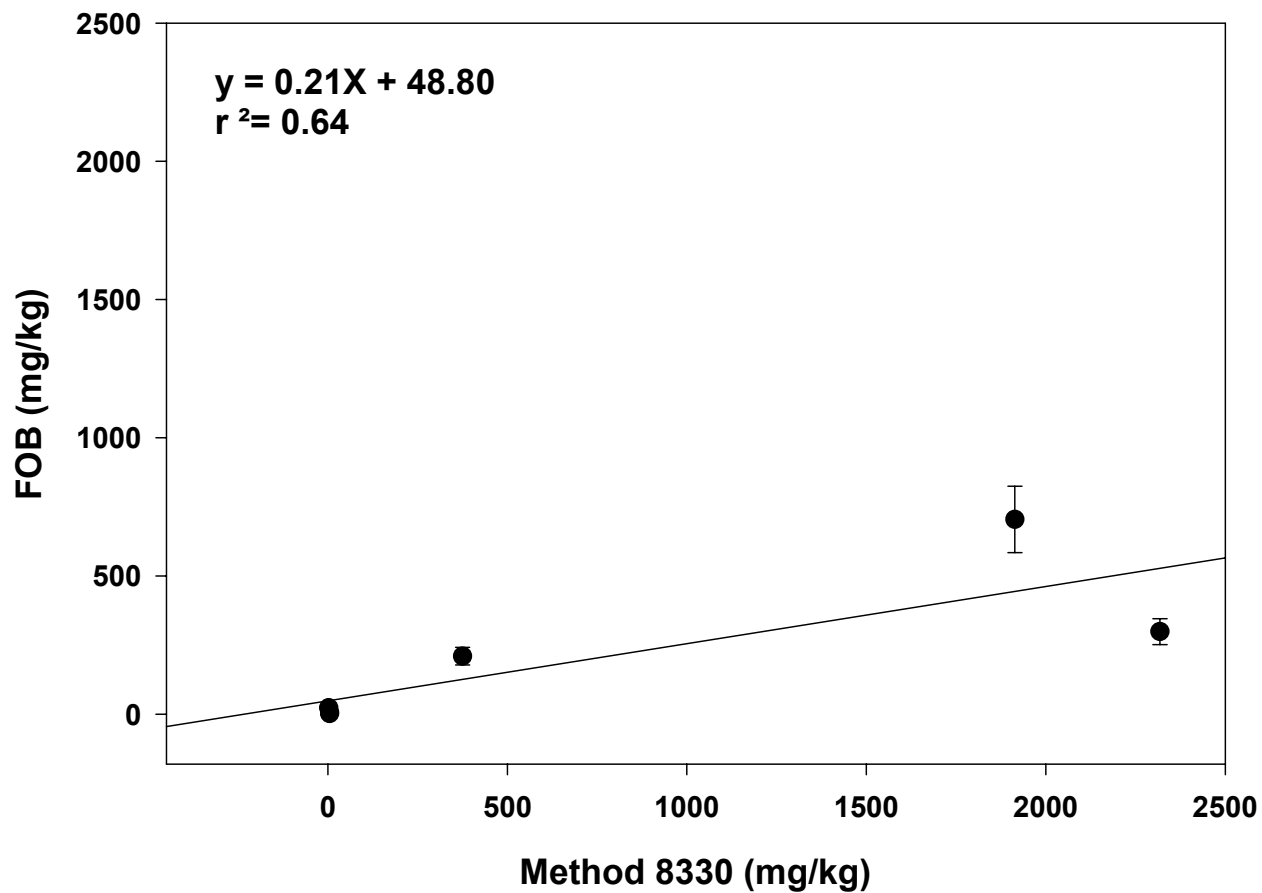


Figure 24

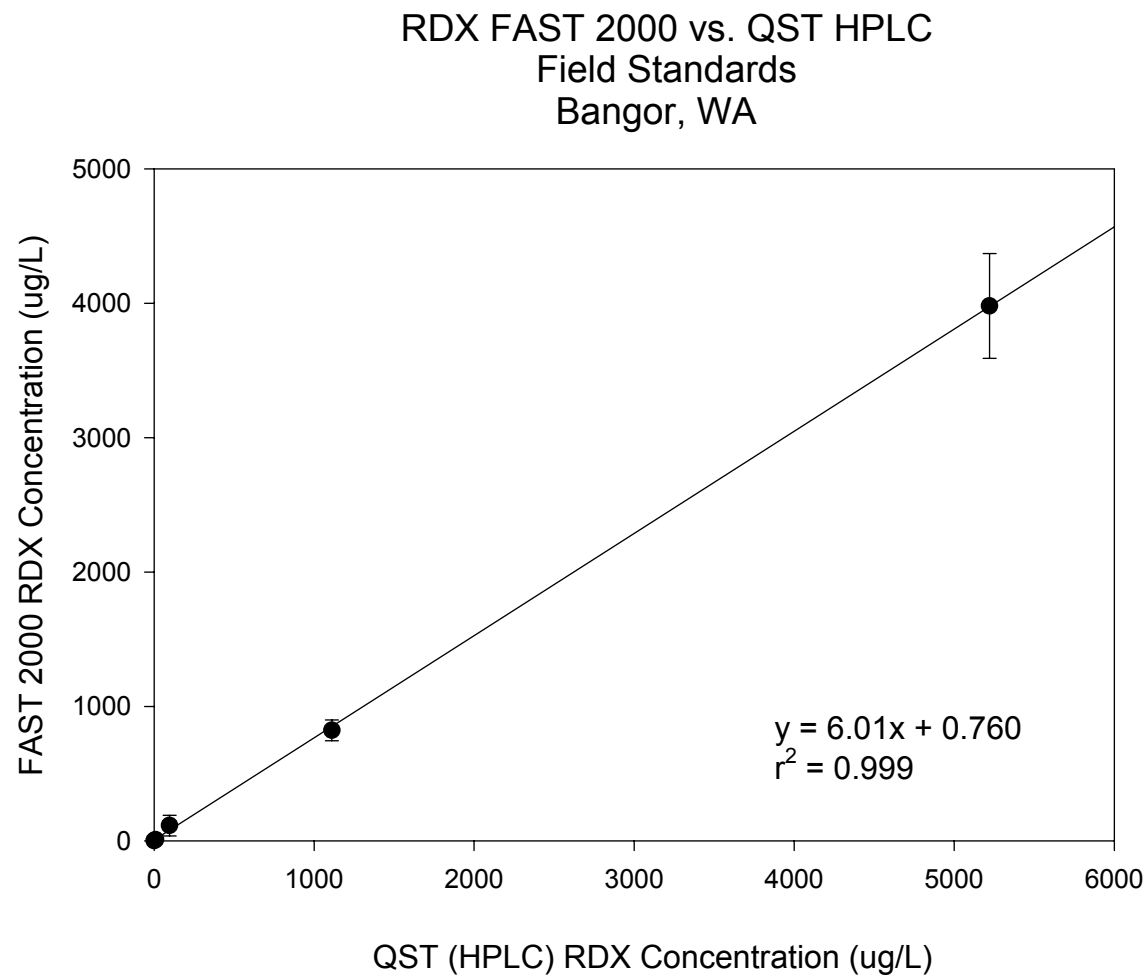


Figure 25

TNT FAST 2000 vs. QST HPLC  
Field Standards  
Bangor, WA

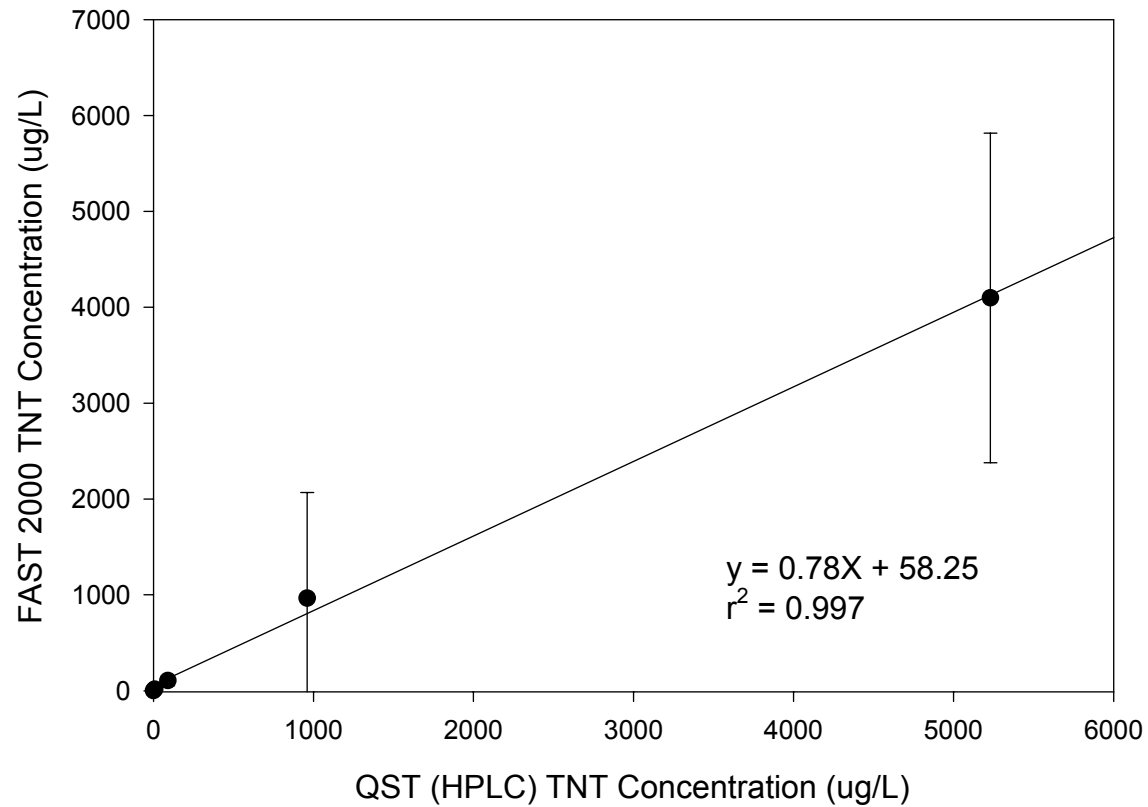


Figure 26

**RDX FAST 2000 vs. QST HPLC**  
**Bangor, WA**

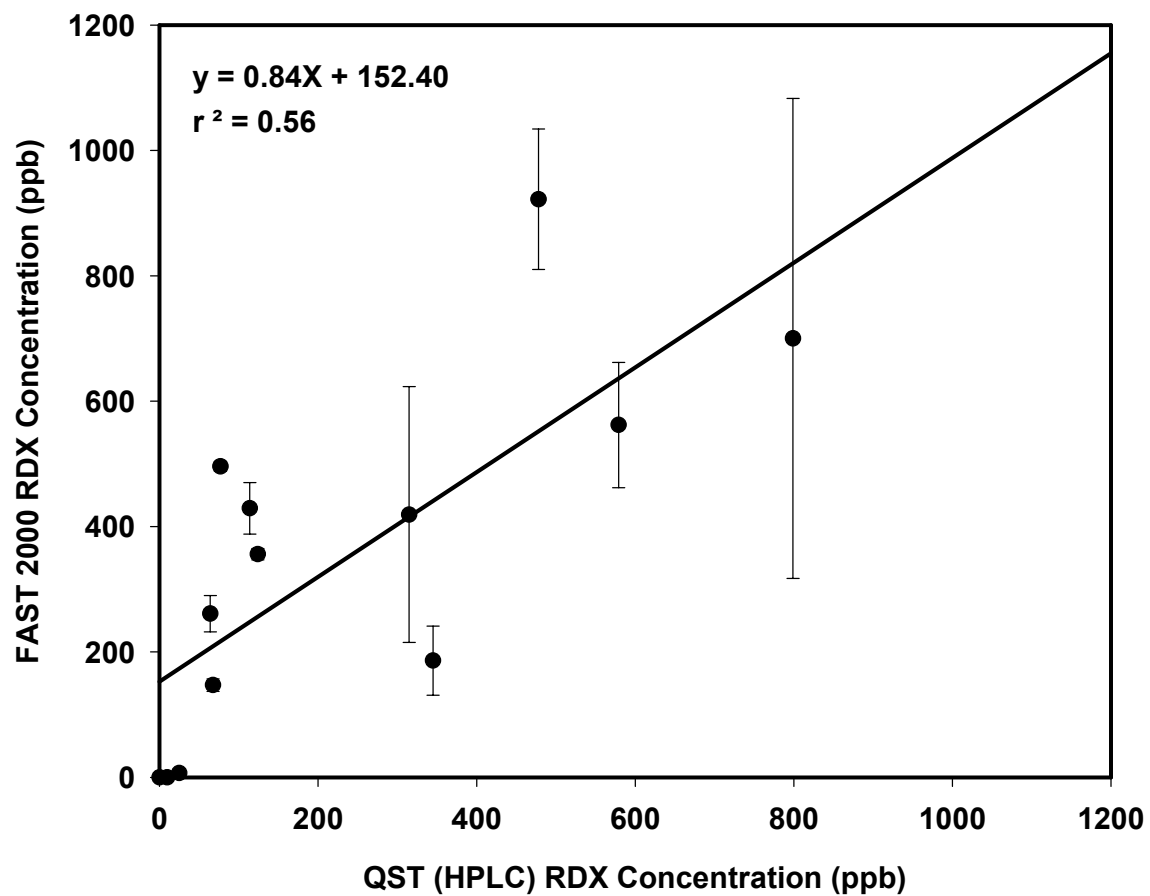


Figure 27

**TNT FAST 2000 vs. QST HPLC  
Bangor, WA**

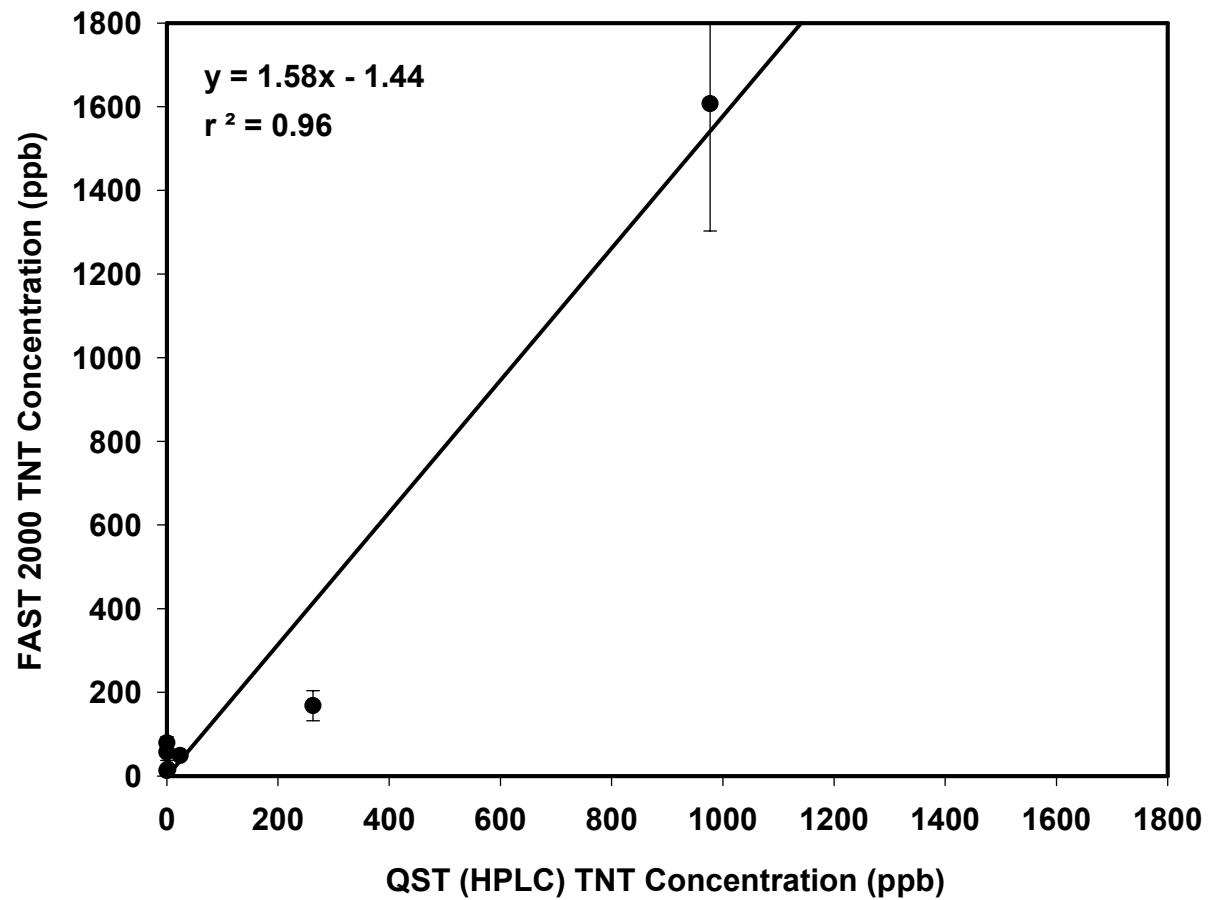


Figure 28

**RDX FAST2000 vs. QST HPLC**  
**Umatilla, OR**

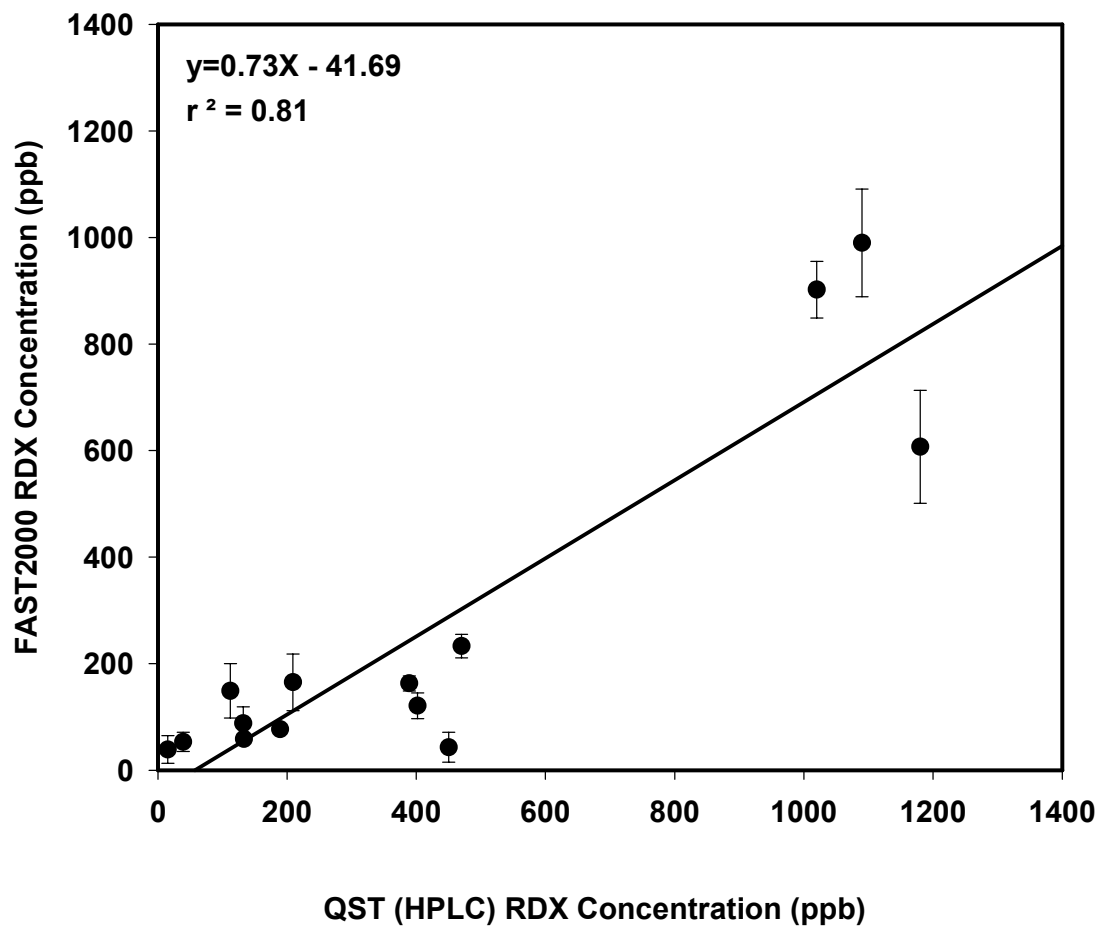


Figure 29

**TNT FAST 2000 vs. QST HPLC**  
**Umatilla, OR**

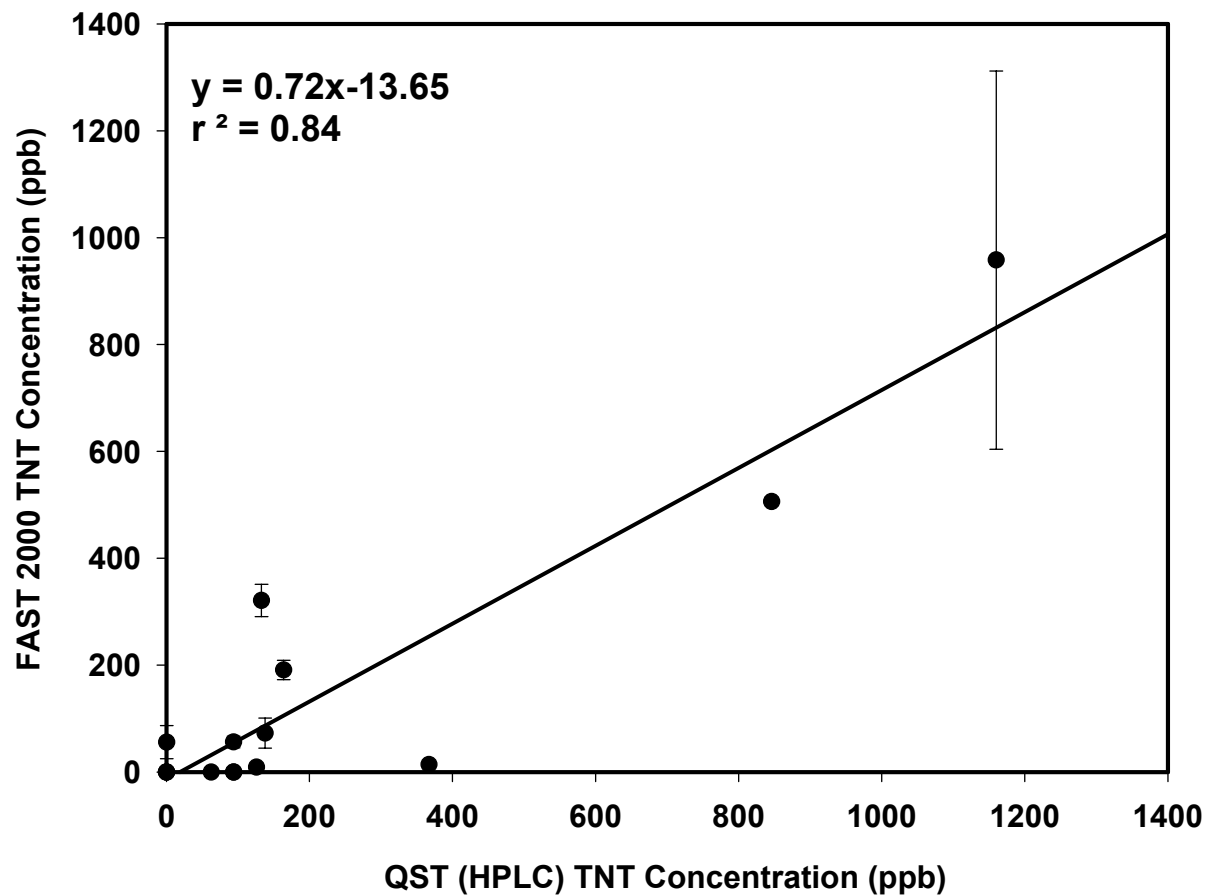


Figure 30

**RDX FAST 2000 vs. QST HPLC**  
**Crane, IN**

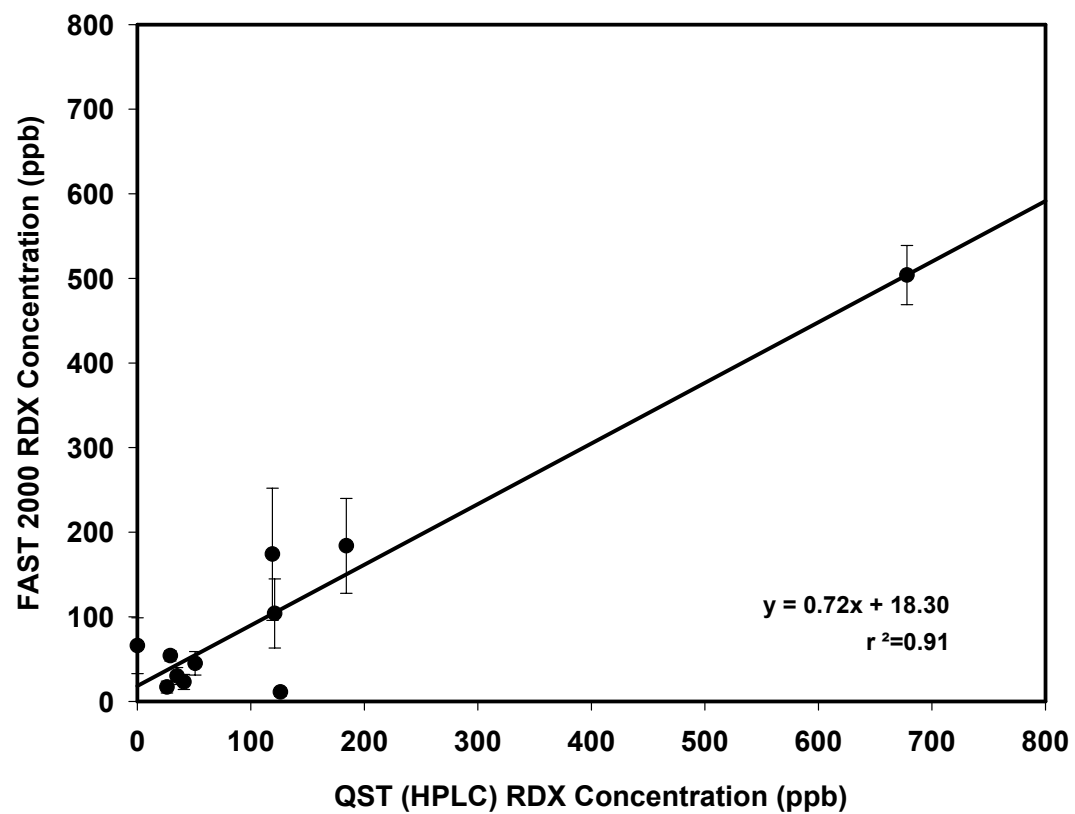


Figure 31

**TNT FAST 2000 vs. QST HPLC  
Crane, IN**

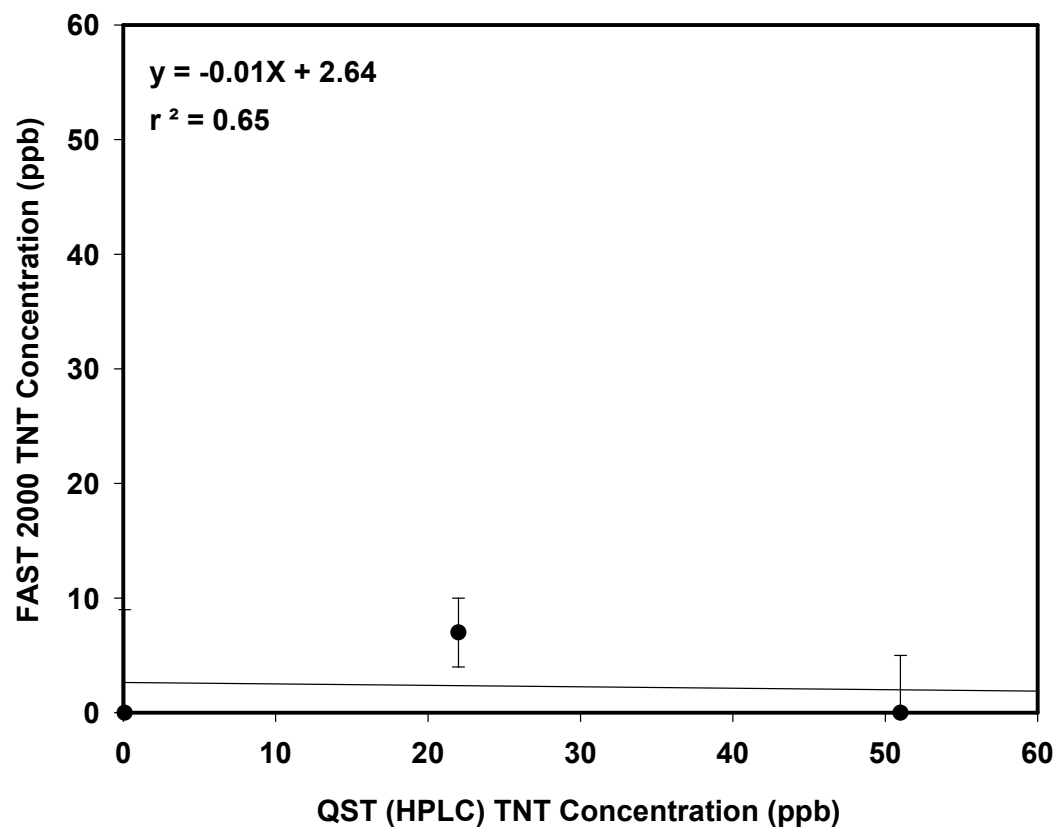


Figure 32

## RDX CFI vs Method 8330

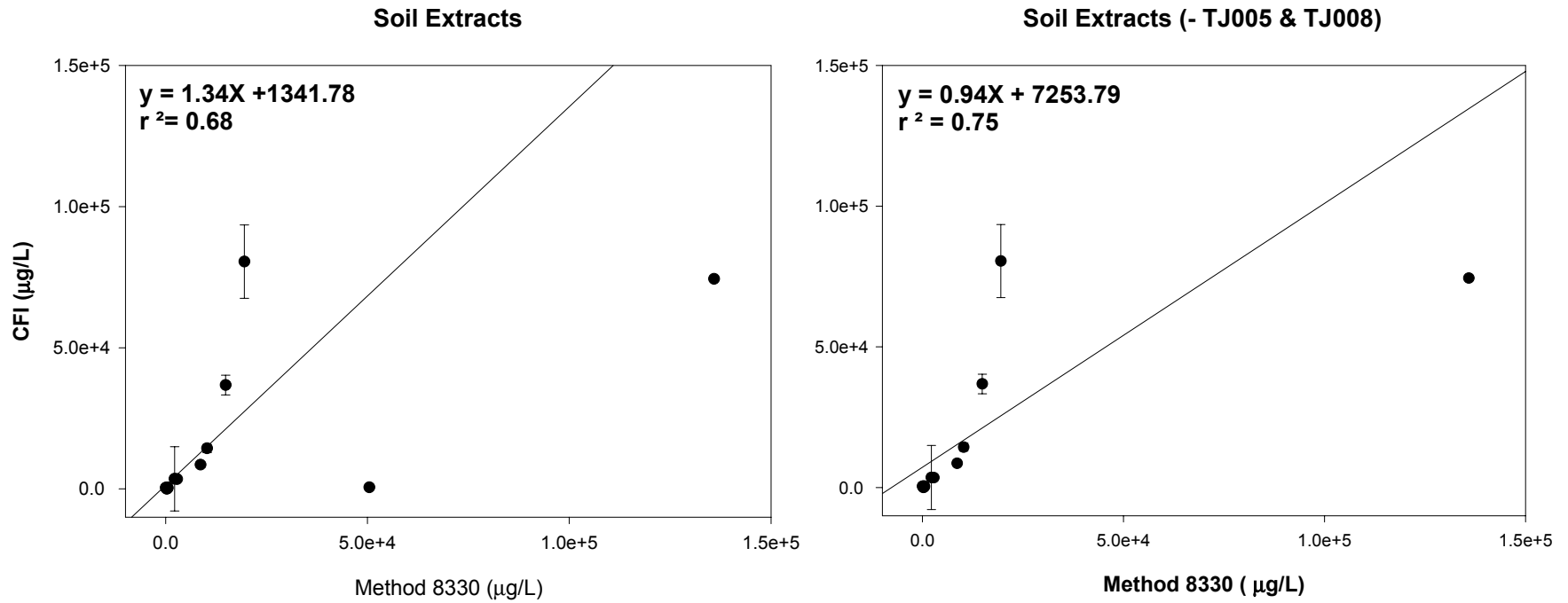
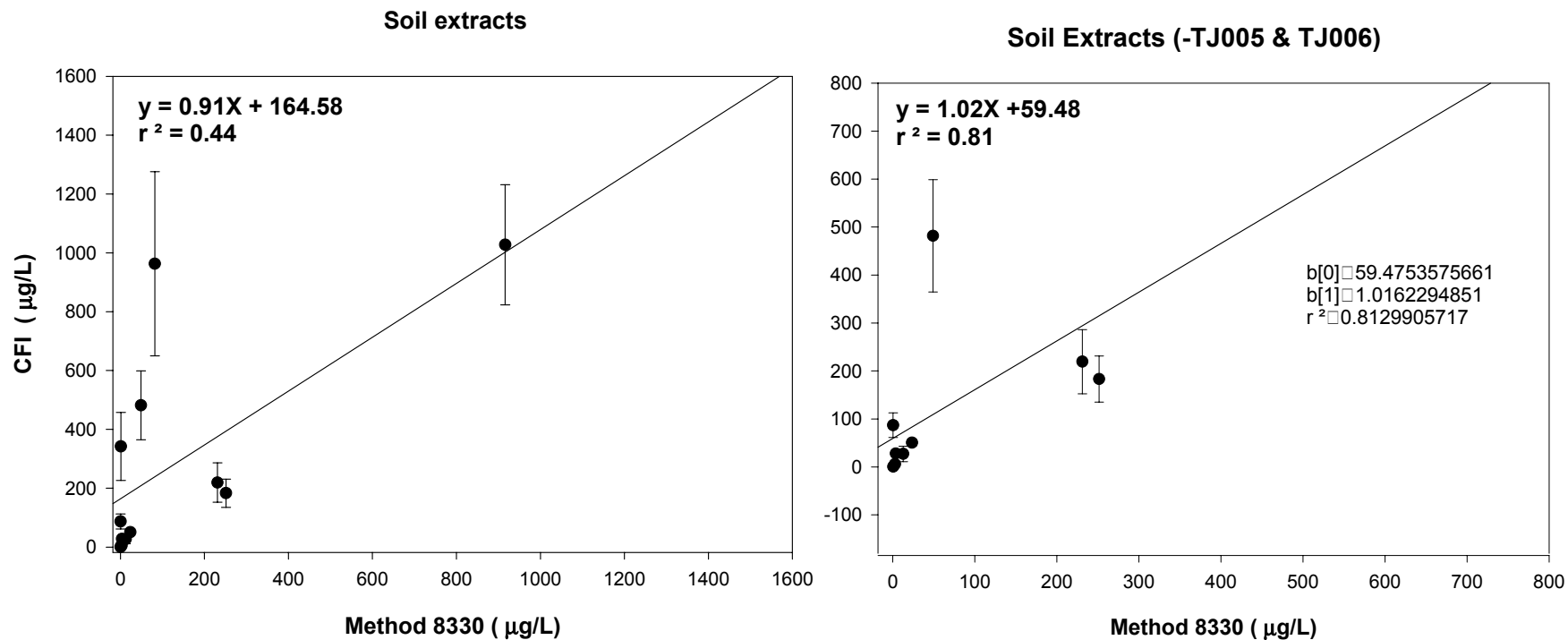


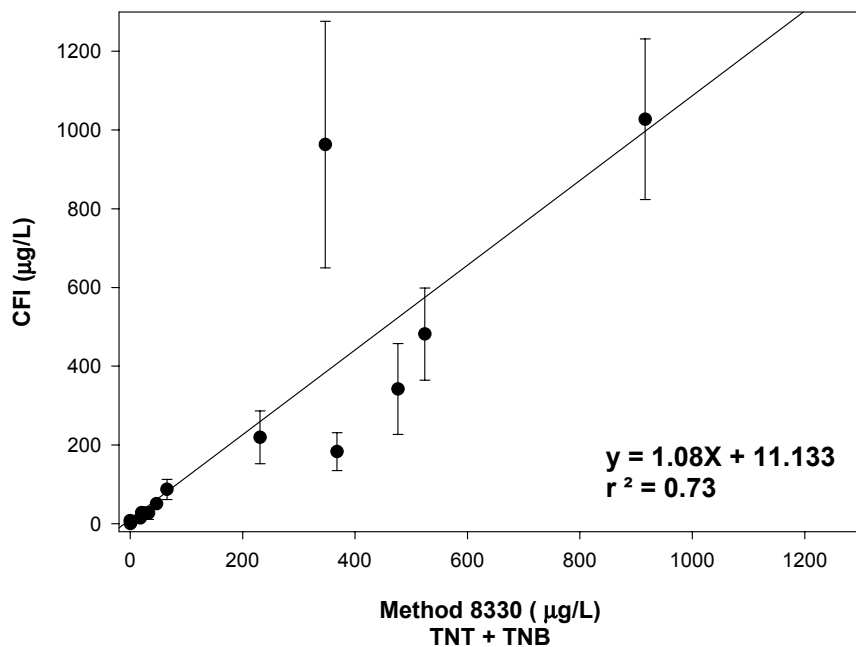
Figure 33

# TNT FAST 2000 vs Method 8330

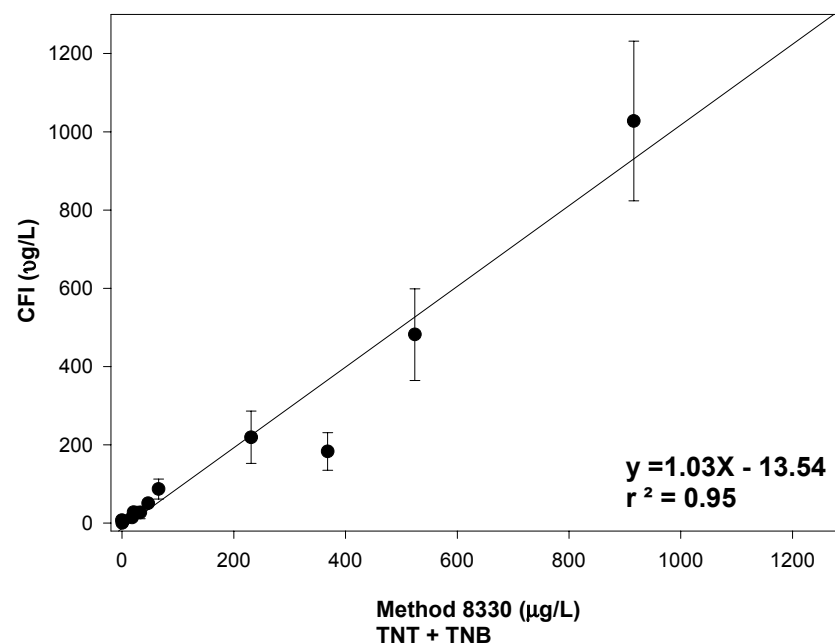


## TNT FAST 2000 vs Method 8330 (TNT + TNB)

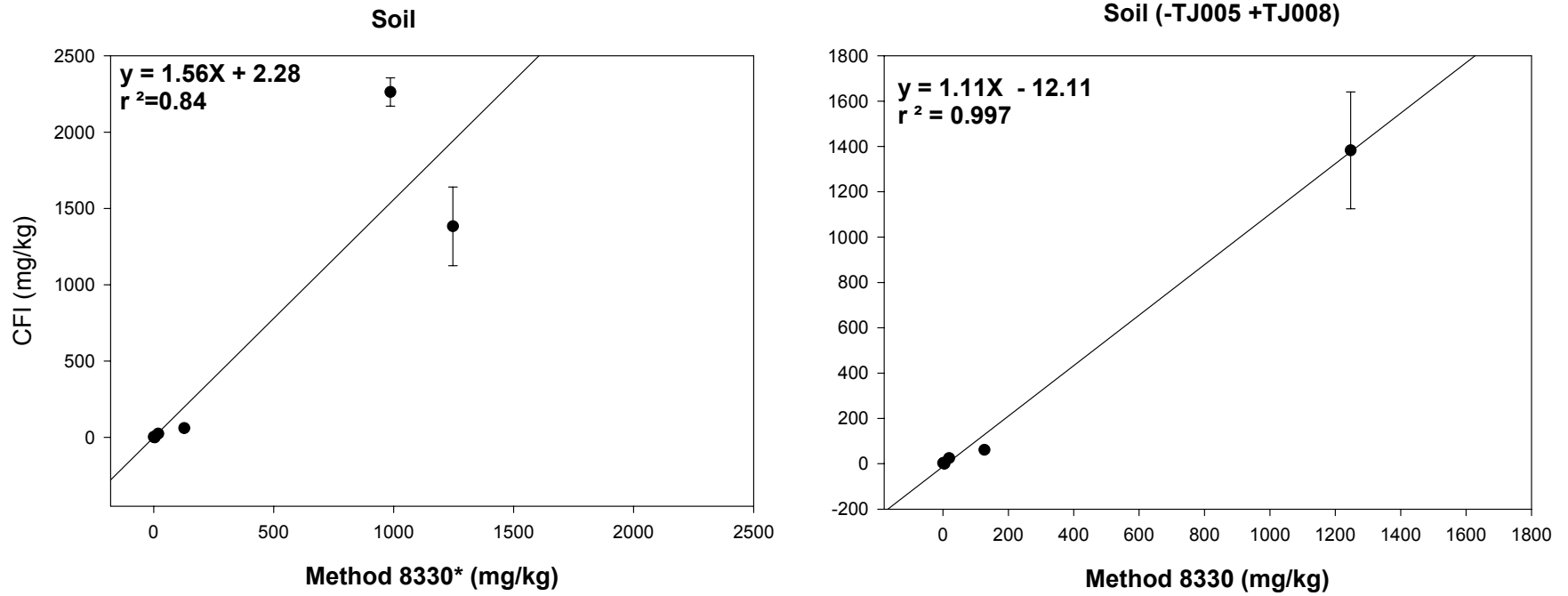
### Soil extracts



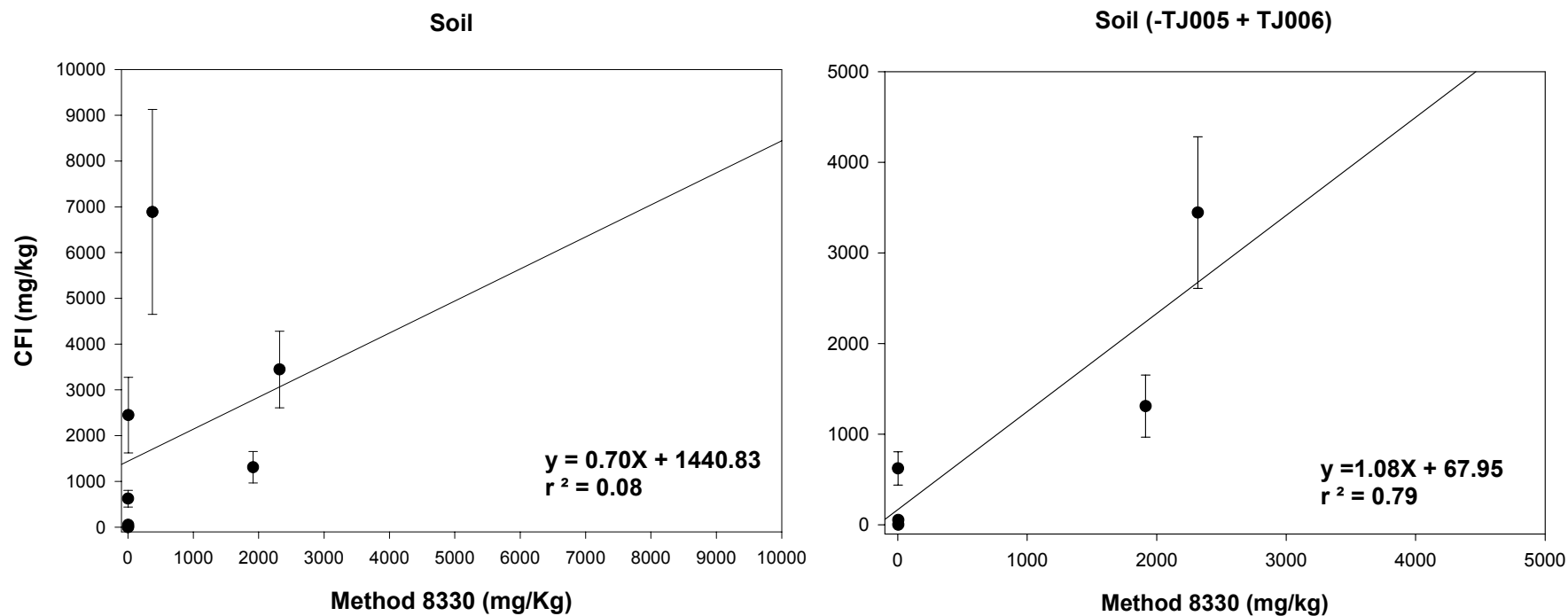
### Soil extracts (-TJ005 +TJ006)



## RDX FAST 2000 vs Method 8330



## TNT FAST vs Method 8330



# Replicate Injections of 5 ng/mL TNT (Test for False Positive Response)

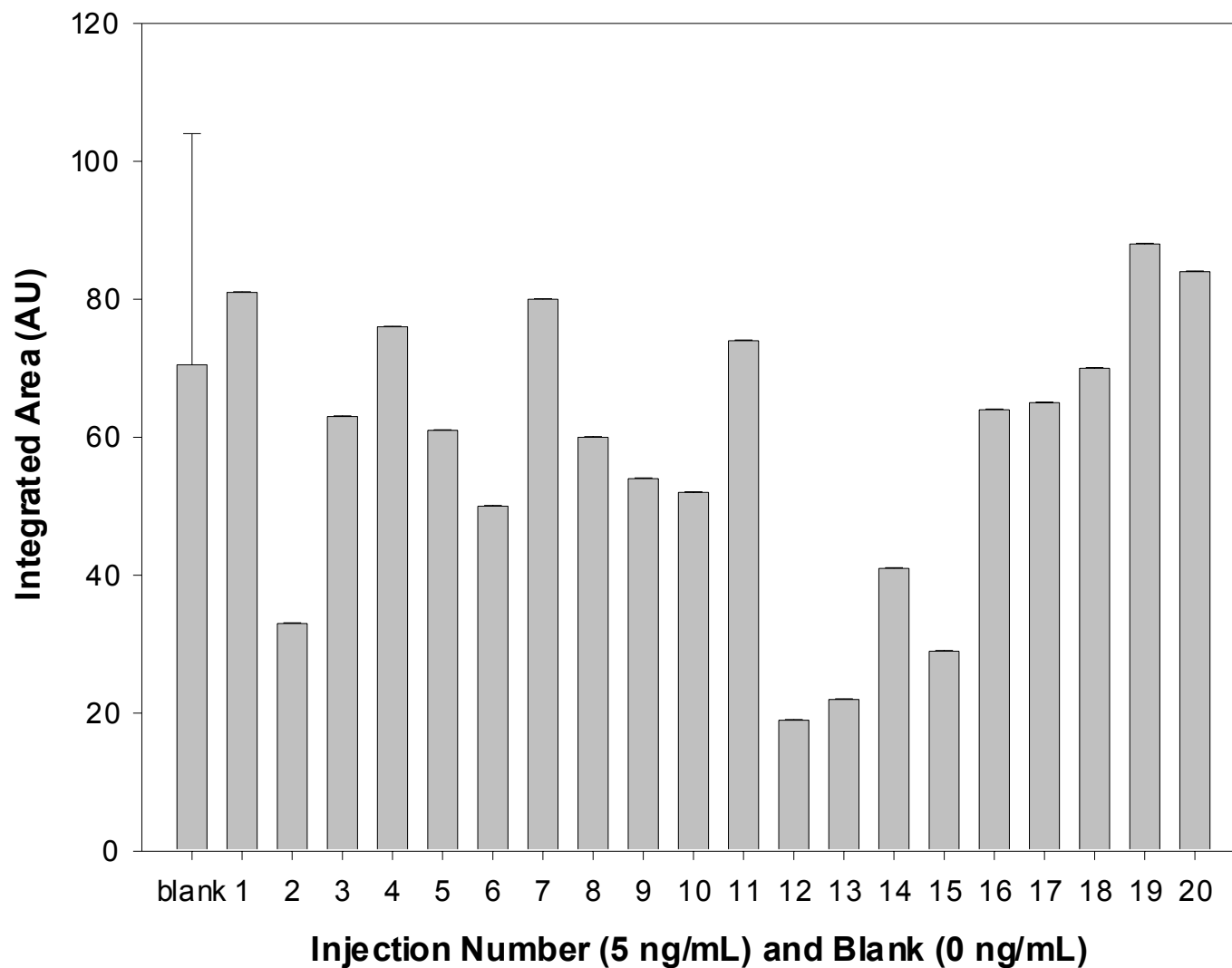


Figure 38

## Replicate Injections of 20 ng/mL TNT (Test for False Negative Response)

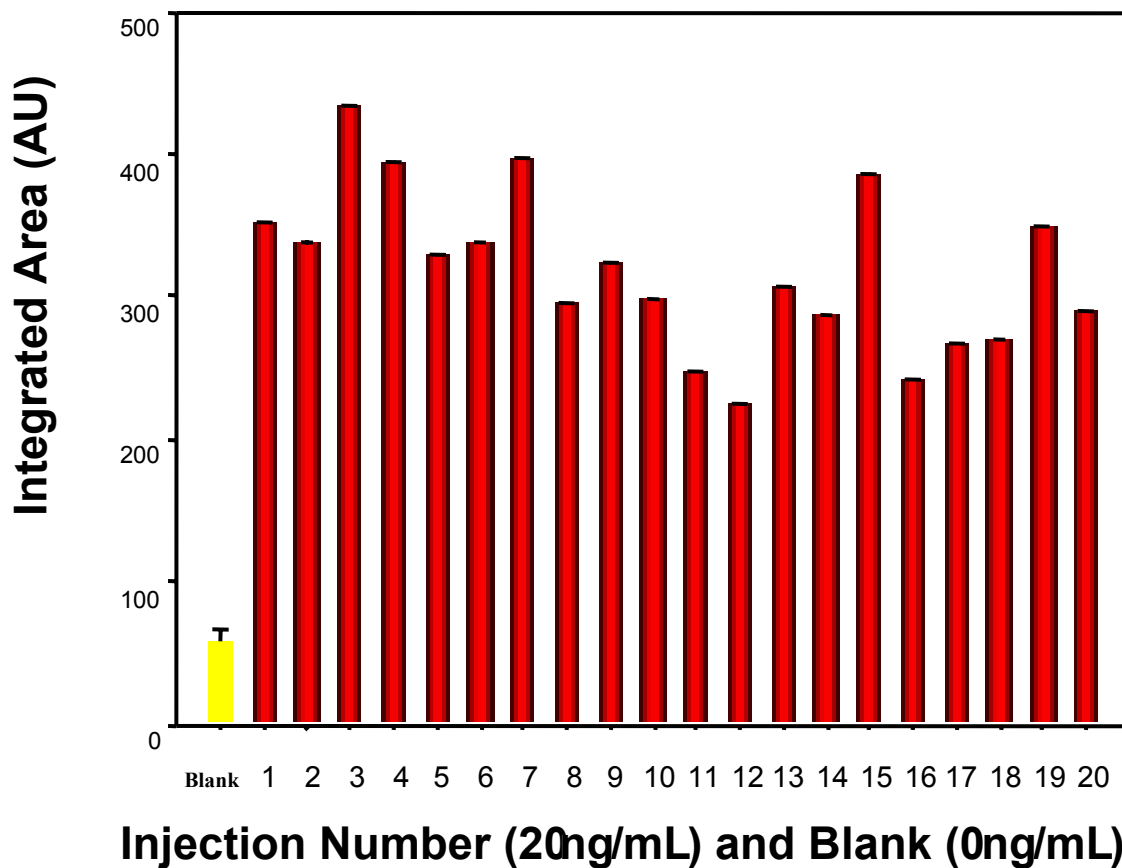
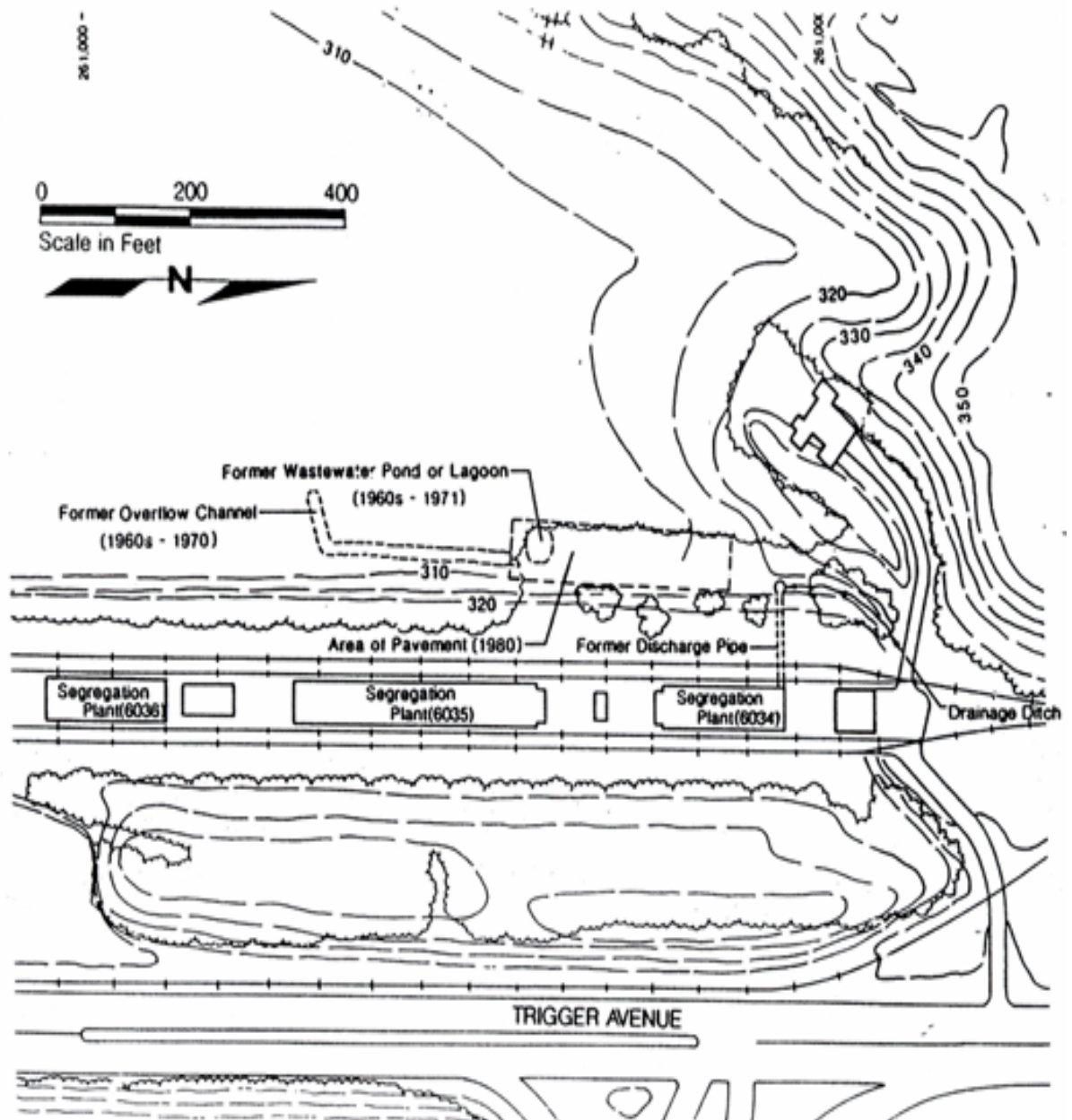


Figure 39

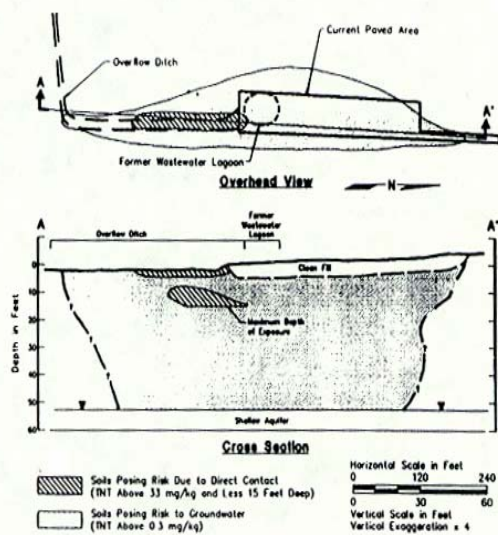
## Site F Historical Features Map



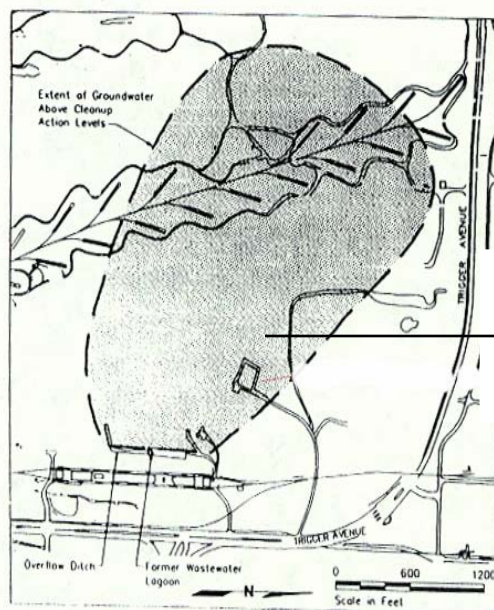
  
**HARTCROWSER**  
J-1463-13 4/93

Figure 9

## SITE F (Operable Unit 2)

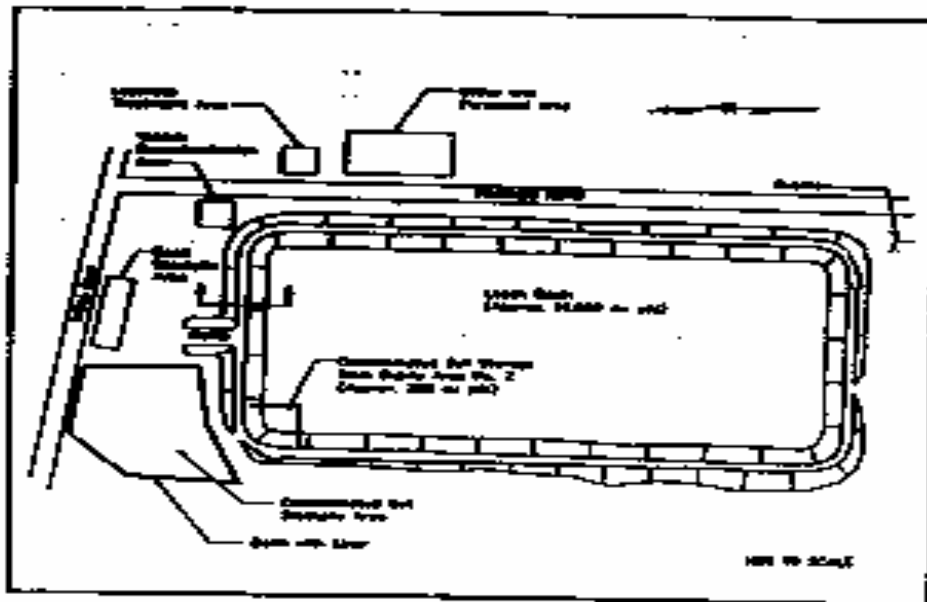


**Extent of Soil Above Cleanup Action Levels**

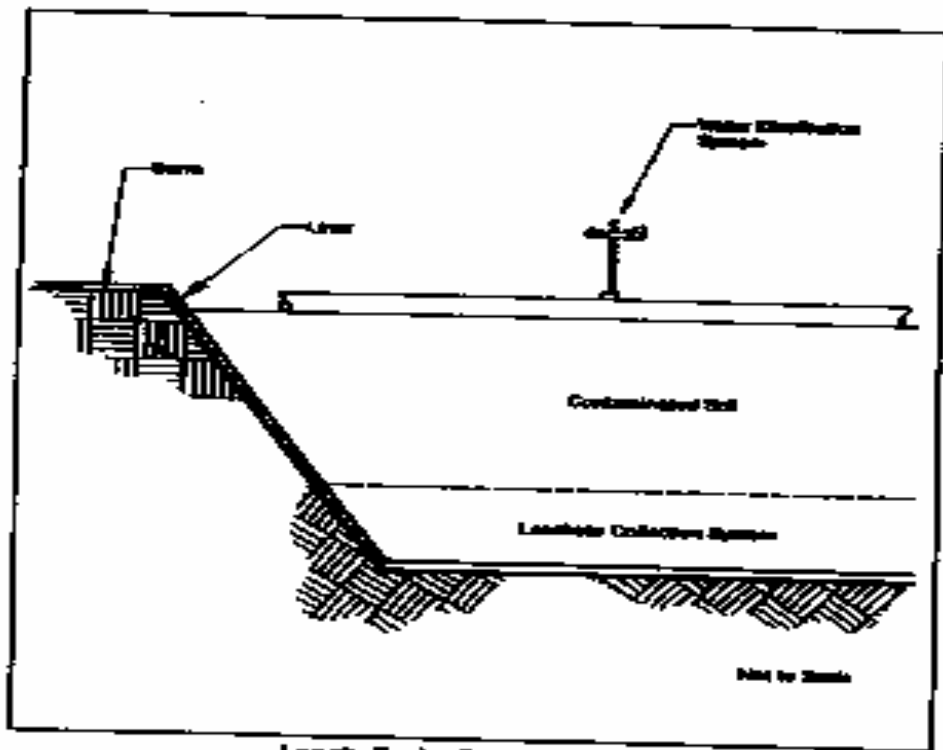


**Extent of Groundwater Above Cleanup Action Levels**

## SITE A (Operable Unit 1)



Schematic of Leach Basin Location and Layout



Leach Basin Conceptual Cross Section

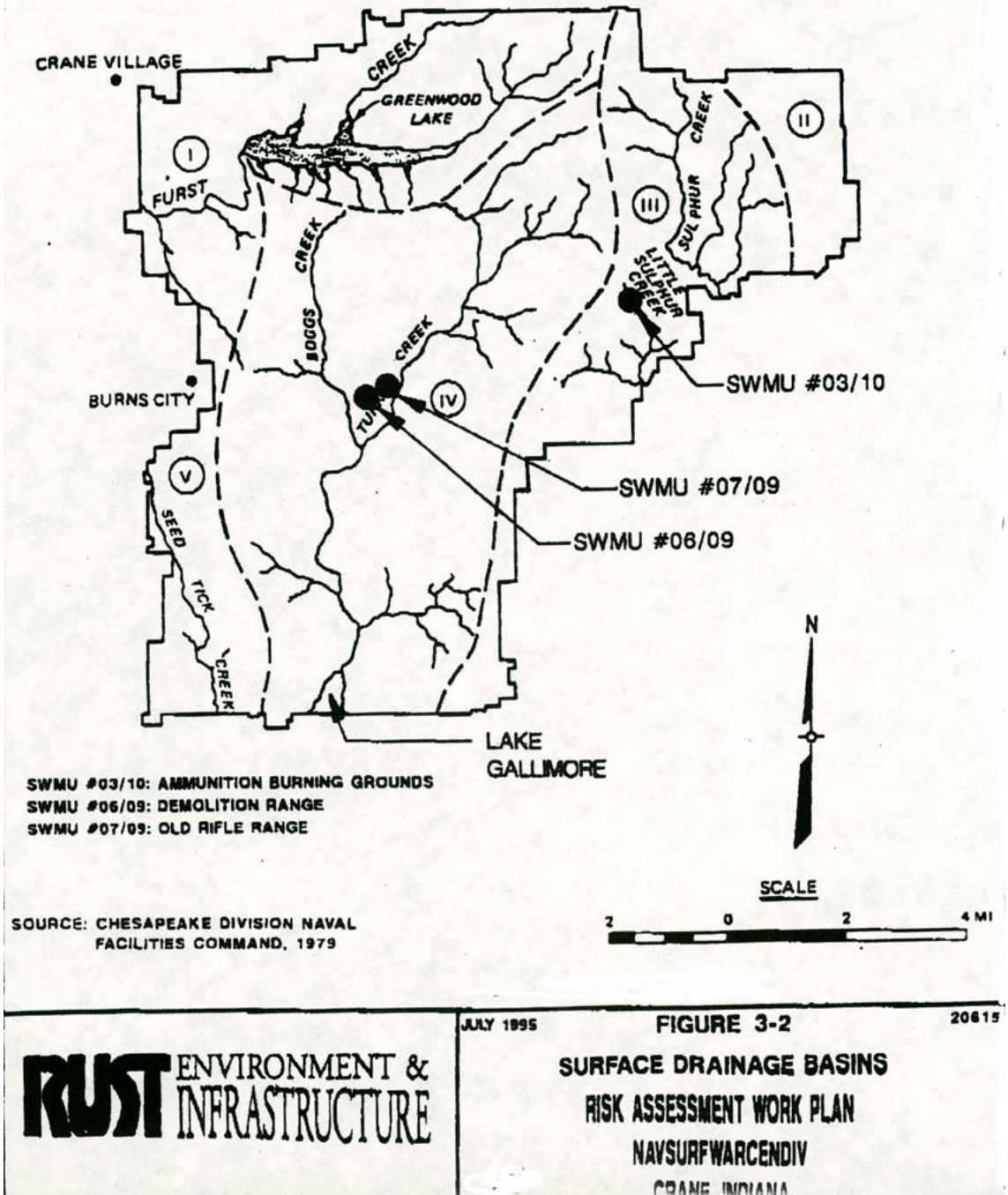
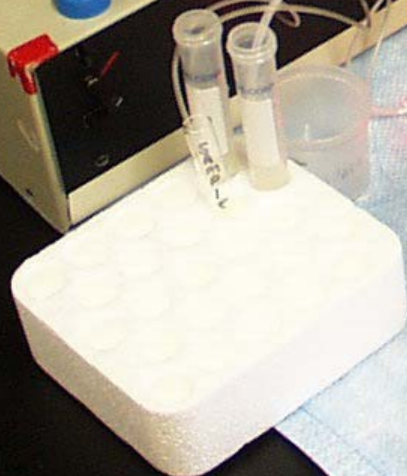


Figure 13





**Bangor Field Trial (June 23-26)**  
**Fiber, TNT and RDX, FLS samples**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 1	0.0	0.0	NA	JL				
1 ppb TNT	0.0	0.0	NA	JL				
	0.0	0.0	NA	JL				
	0.0	0.0	NA	JL				
	0.0	0.0	NA	SVB				
	9.7	4.1	NA	SVB				
	11.5	5.5	NA	SVB				
	16.4	9.2	NA	SVB				
Average	4.7	2.3						
St. Dev.	6.7	3.5						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-15	40.9	35.6	NA	SVB				
100 ppb TNT,	42.7	38.6	NA	SVB				
2,4DNT	44.3	41.6	NA	SVB				
	45.4	43.7	NA	SVB				
	34.4	26.4	NA	JL				
	33.7	25.6	NA	JL				
	37.9	31.1	NA	JL				
	32.8	24.5	NA	JL				
Average	39.0	33.4						
St. Dev.	5.0	7.6						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 2	18.5	10.9	NA	JL				
10 ppb TNT	15.9	8.8	NA	JL				
	20.5	12.5	NA	JL				
	18.3	10.7	NA	JL				
	10.8	4.9	NA	SVB				
	6.7	1.6	NA	SVB				
	10.9	5.0	NA	SVB				
	17.7	10.2	NA	SVB				
Average	14.9	8.1						
St. Dev.	4.9	3.8						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-16	53.7	65.8	NA	SVB				
100 ppb TNT,	48.7	51.1	NA	SVB				
2amino	42.5	38.3	NA	SVB				
	40.5	35.0	NA	SVB				
	32.8	24.5	NA	JL				
	35.3	27.6	NA	JL				
	38.0	31.2	NA	JL				
	38.8	32.4	NA	JL				
Average	41.3	38.2						
St. Dev.	6.9	13.7						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 3	16.2	9.1	NA	JL				
100 ppb TNT	47.3	47.8	NA	JL				
	29.7	21.1	NA	JL				
	41.4	36.4	NA	JL				
	41.7	36.9	NA	SVB				
	38.5	31.9	NA	SVB				
	48.9	51.6	NA	SVB				
	54.9	70.2	NA	SVB				
Average	39.8	38.1						
St. Dev.	12.2	18.8						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-17	46.2	45.4	NA	SVB				
100 ppb TNT,TNB,	45.1	43.1	NA	SVB				
2,4DNT	49.5	53.1	NA	SVB				
	50.5	55.8	NA	SVB				
	46.5	46.0	NA	JL				
	44.7	42.4	NA	JL				
	49.2	52.4	NA	JL				
	49.1	52.1	NA	JL				
Average	47.6	48.8						
St. Dev.	2.2	5.1						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 4	78.6	#NUM!	NA	JL				
1000 ppb TNT	85.9	#NUM!	NA	JL				
	82.5	#NUM!	NA	JL				
	84.9	#NUM!	NA	JL				
	79.9	#NUM!	NA	SVB				
	75.8	#NUM!	NA	SVB				
	83.3	#NUM!	NA	SVB				
	85.6	#NUM!	NA	SVB				
Average	82.1	#NUM!						
St. Dev.	3.6	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-18	47.9	49.2	NA	SVB				
100 ppb TNT,TNB,	48.7	51.1	NA	SVB				
2aDNT	51.5	58.7	NA	SVB				
	53.3	64.4	NA	SVB				
	34.3	26.3	NA	JL				
	36.0	28.5	NA	JL				
	43.9	40.8	NA	JL				
	40.0	34.2	NA	JL				
Average	44.5	44.2						
St. Dev.	7.1	14.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 5	90.0	#NUM!	NA	SVB				
5000 ppb TNT	81.8	#NUM!	NA	SVB				
	90.5	#NUM!	NA	SVB				
	88.8	#NUM!	NA	SVB				
	80.4	#NUM!	NA	JL				
	89.5	#NUM!	NA	JL				
	80.7	#NUM!	NA	JL				
*mixed fibers	84.6	#NUM!	NA	JL				
Average	85.8	#NUM!						
St. Dev.	4.4	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-19	-3.5	0.0	NA	SVB				
100 ppb HMX	-2.2	0.0	NA	SVB				
	0.5	0.0	NA	SVB				
	1.6	0.0	NA	SVB				
	-3.6	0.0	NA	JL				
	-9.2	0.0	NA	JL				
	-2.8	0.0	NA	JL				
	-3.2	0.0	NA	JL				
Average	-2.8	0.0						
St. Dev.	3.2	0.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-6	3.6	0.0	NA	SVB	-0.6	0.0	NA	SVB
1ppb RDX	5.9	0.9	NA	SVB	-5.7	0.0	NA	SVB
	3.9	0.0	NA	SVB	-5.7	0.0	NA	SVB
	3.4	0.0	NA	SVB	22.8	13.1	NA	SVB
	4.5	0.0	NA	JL				
	-0.6	0.0	NA	JL				
	6.3	1.2	NA	JL				
	7.1	2.0	NA	JL				
Average	4.3	0.5			2.7	3.3		
St. Dev.	2.4	0.8			13.6	6.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-20	15.2	8.3	NA	SVB				
100 ppb HMX,	8.9	3.5	NA	SVB				
RDX	22.5	14.2	NA	SVB				
	23.5	15.1	NA	SVB				
	22.6	14.3	NA	JL				
	0.3	0.0	NA	JL				
	24.1	15.6	NA	JL				
	26.3	17.7	NA	JL				
Average	17.9	11.1						
St. Dev.	9.1	6.4						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-7	-13.8	0.0	NA	SVB	26.9	16.3	NA	SVB
10 ppb RDX	-15.4	0.0	NA	SVB	24.7	14.6	NA	SVB
	-12.3	0.0	NA	SVB	26.5	16.0	NA	SVB
	-8.6	0.0	NA	SVB	18.6	9.9	NA	SVB
	47.6	48.5	NA	JL	16.4	8.3	NA	JL
	33.4	25.2	NA	JL	16.1	8.1	NA	JL
	48.6	50.9	NA	JL	16.7	8.5	NA	JL
	12.1	5.9	NA	JL	16.5	8.4	NA	JL
Average	11.5	16.3			20.3	11.2		
St. Dev.	28.0	22.3			4.8	3.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-21	37.8	30.9	NA	SVB				
100 ppb RDX,	36.1	28.6	NA	SVB				
TNT	45.2	43.3	NA	SVB				
	45.0	42.9	NA	SVB				
	71.4	332.2	NA	JL				
	79.2	#NUM!	NA	JL				
	60.9	101.5	NA	JL				
	69.2	225.4	NA	JL				
Average	55.6	#NUM!						
St. Dev.	16.6	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-8	-7.8	0.0	NA	JL	57.2	49.4	NA	SVB
100 ppb RDX	-1.5	0.0	NA	JL	58.1	50.9	NA	SVB
	4.8	0.0	NA	JL	63.1	60.3	NA	SVB
	-2.5	0.0	NA	JL	78.4	110.1	NA	JL
	2.7	0.0	NA	SVB	78.6	111.2	NA	JL
	1.9	0.0	NA	SVB	82.4	135.2	NA	JL
	2.7	0.0	NA	SVB	83.8	146.6	NA	JL
	3.3	0.0	NA	SVB				
Average	0.4	0.0			71.7	94.8		
St. Dev.	4.1	0.0			11.7	40.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-22	38.8	32.4	NA	SVB				
100 ppb HMX,	39.4	33.3	NA	SVB				
RDX,TNT	43.3	39.7	NA	SVB				
	44.9	42.7	NA	SVB				
	27.9	19.2	NA	JL				
	27.5	18.9	NA	JL				
	35.3	27.6	NA	JL				
	19.3	11.5	NA	JL				
Average	34.6	28.2						
St. Dev.	8.9	10.9						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-9	58.9	88.8	NA	JL	98.5	2953.6	NA	JL
1000 ppb RDX	46.1	45.2	NA	JL	100.0	#NUM!	NA	JL
	53.2	64.1	NA	JL	100.0	#NUM!	NA	JL
	54.0	66.9	NA	JL	100.0	#NUM!	NA	JL
	27.7	19.0	NA	SVB	99.8	#NUM!	NA	SVB
	28.7	20.1	NA	SVB	99.3	#NUM!	NA	SVB
	28.1	19.4	NA	SVB	98.7	5960.2	NA	SVB
	31.7	23.3	NA	SVB				
Average	41.1	43.3			99.5	#NUM!		
St. Dev.	13.3	27.2			0.6	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-10	6.9	1.8	NA	SVB	100.0	#NUM!	NA	SVB
5000 ppb RDX	5.6	0.5	NA	SVB	100.0	#NUM!	NA	SVB
	10.3	4.5	NA	SVB	100.0	#NUM!	NA	SVB
	7.6	2.4	NA	SVB	100.0	#NUM!	NA	JL
	2.5	0.0	NA	JL	100.0	#NUM!	NA	JL
	0.9	0.0	NA	JL	100.0	#NUM!	NA	JL
	3.8	0.0	NA	JL	100.0	#NUM!	NA	JL
	7.1	2.0	NA	JL				
Average	5.6	1.4			100.0	#NUM!		
St. Dev.	3.0	1.6			0.0	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-11	25.7	17.1	NA	SVB				
100 ppb TNB	28.5	19.9	NA	SVB				
	30.7	22.2	NA	SVB				
	33.8	25.7	NA	SVB				
	12.1	5.9	NA	JL				
	19.0	11.3	NA	JL				
	11.0	5.1	NA	JL				
	2.3	0.0	NA	JL				
Average	20.4	13.4						
St. Dev.	11.1	9.2						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-12	4.2	0.0	NA	JL				
100 ppb 2,4DNT	5.5	0.4	NA	JL				
	4.0	0.0	NA	JL				
	2.1	0.0	NA	JL				
	8.1	2.8	NA	SVB				
	8.0	2.7	NA	SVB				
	8.5	3.1	NA	SVB				
	8.9	3.5	NA	SVB				
Average	6.2	1.6						
St. Dev.	2.6	1.6						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-13	6.3	1.2	NA	JL				
100 ppb 2amDNT	20.1	12.2	NA	JL				
	13.3	6.8	NA	JL				
	18.6	11.0	NA	JL				
	12.2	6.0	NA	SVB				
	13.3	6.8	NA	SVB				
	15.0	8.1	NA	SVB				
	14.9	8.1	NA	SVB				
Average	14.2	7.5						
St. Dev.	4.2	3.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-14	50.2	55.0	NA	JL				
100 ppb TNT,	46.2	45.4	NA	JL				
TNB	52.6	62.1	NA	JL				
	60.5	98.7	NA	JL				
	47.5	48.3	NA	SVB				
	49.2	52.4	NA	SVB				
	50.0	54.5	NA	SVB				
	52.3	61.1	NA	SVB				
Average	51.1	59.7						
St. Dev.	4.4	16.8						

#### Effluent and Influent samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EFF1	0.0	0.0	NA	JL	100.0	#NUM!	NA	SM
	0.0	0.0	NA	JL	100.0	#NUM!	NA	SM
	0.0	0.0	NA	JL	0.0	0.0	NA	CR*
	23.7	15.3	NA	JL	0.0	0.0	NA	CR*
	0.0	0.0	NA	SVB	0.0	0.0	NA	LA*
	0.0	0.0	NA	SVB	15.0	7.2	NA	AZ
	0.0	0.0	NA	SVB	2.0	0.0	NA	AZ
	1.2	0.0	NA	SVB	1.0	0.0	NA	AZ
	2.6	0.0	NA	CR*	0.0	0.0	NA	AZ
	0.0	0.0	NA	CR*				
	0.0	0.0	NA	LA*				
	4.0	0.0	NA	LA*				
	7.0	1.9	NA	SM				
*=mixed fibers	27.0	18.4	NA	SM				
Average	4.7	2.5			24.2	#NUM!		
St. Dev.	9.0	6.1			43.2	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
INF1	11.0	5.1	NA	SM	73.9	90.3	NA	CR*
	3.0	0.0	NA	SM	89.7	225.5	NA	CR*
	1.9	0.0	NA	CR*	85.0	157.9	NA	LA*
	0.0	0.0	NA	CR*	85.0	157.9	NA	AZ
	0.0	0.0	NA	LA*	92.0	286.3	NA	AZ
*=mixed fibers	0.0	0.0	NA	LA*	92.0	286.3	NA	AZ
					92.0	286.3	NA	AZ
Average	2.7	0.8			87.1	212.9		
St. Dev.	4.3	2.1			6.6	79.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
INF2	0.0	0.0	NA	LA*	93.0	325.4	NA	LA*
	0.0	0.0	NA	LA*	88.0	195.2	NA	LA*
	4.2	0.0	NA	CR*	100.0	#NUM!	NA	AZ
	3.6	0.0	NA	CR*	100.0	#NUM!	NA	AZ
	0.0	0.0	NA	SM	97.0	804.6	NA	AZ
	0.0	0.0	NA	SM	97.0	804.6	NA	AZ
	0.0	0.0	NA	SM	97.0	804.6	NA	CR*
*=mixed fibers	0.0	0.0	NA	SM	95.0	454.0	NA	CR*
Average	1.0	0.0			95.9	#NUM!		
St. Dev.	1.8	0.0			3.9	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
INF 1					36.8	24.7	1:10	IB
					31.2	19.8	1:10	IB
					29.1	18.1	1:10	IB
					25.9	15.5	1:10	IB
					55.5	46.7	1:10	IB
					49	37.7	1:10	IB
					50.7	39.9	1:10	IB
*=mixed fibers					41.2	29	1:10	IB
Average					39.9	28.9		
St. Dev.					11.0	11.4		

## Bangor SUBASE, Fiber, TNT and RDX, EW samples

## Undiluted

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW2	20.0	12.1	NA	LA*	82.0	132.2	NA	LA*
	13.0	6.6	NA	LA*	63.9	62.0	NA	LA*
	22.0	13.8	NA	AZ*	90.0	231.8	NA	AZ*
	26.0	17.4	NA	AZ*	93.0	325.4	NA	AZ*
	46.1	45.2	NA	CR*	96.7	716.0	NA	CR*
	37.8	30.9	NA	CR*	89.3	217.5	NA	CR*
	11.9	5.8	NA	SVB	67.2	69.7	NA	JL
	8.1	2.8	NA	SVB	72.6	85.6	NA	JL
	15.3	8.4	NA	SVB	68.1	72.1	NA	JL
	17.8	10.3	NA	SVB	80.5	122.1	NA	NN
	24.5	16.0	NA	JL	59.5	53.4	NA	NN
	27.7	19.0	NA	JL	67.9	71.5	NA	NN
	30.1	21.5	NA	JL	47.0	35.3	NA	SM
	27.0	18.4	NA	JL				
Average	23.4	16.3			75.2	168.8		
St. Dev.	10.3	11.1			14.8	185.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW3	63.0	118.5	NA	SM	100.0	#NUM!	NA	LA*
	66.0	154.3	NA	SM	94.0	378.1	NA	LA*
	72.0	383.1	NA	SM	66.8	68.7	NA	CR*
	73.0	520.8	NA	LA*	86.5	174.6	NA	CR*
	73.0	520.8	NA	LA*				
	68.2	197.0	NA	CR*				
	69.5	235.6	NA	CR*				
*=mixed fibers								
Average	69.2	304.3			86.8	#NUM!		
St. Dev.	3.8	169.9			14.4	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW4	10.0	4.3	NA	LA*	85.0	157.9	NA	LA*
	20.0	12.1	NA	LA*	88.0	195.2	NA	LA*
	9.5	3.9	NA	SM	87.9	193.7	NA	CR*
	0.0	0.0	NA	SM	76.7	101.9	NA	CR*
	0.0	0.0	NA	SM	89.0	211.9	NA	AZ
	0.0	0.0	NA	CR*	89.0	211.9	NA	AZ
	0.0	0.0	NA	CR*				
	35.5	27.8	NA	SVB				
	33.9	25.8	NA	SVB				
	33.2	25.0	NA	SVB				
	32.2	23.8	NA	SVB				
	26.0	17.4	NA	JL				
	30.5	21.9	NA	JL				
	26.4	17.8	NA	JL				
	27.4	18.8	NA	JL				
Average	19.0	13.2			85.9	178.8		
St. Dev.	14.1	10.8			4.8	42.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW5	0.0	0.0	NA	CR*	74.8	93.8	NA	CR*
	0.0	0.0	NA	CR*	81.0	125.4	NA	LA*
	0.0	0.0	NA	LA*	78.0	108.1	NA	LA*
	9.0	3.5	NA	LA*	90.0	231.8	NA	AZ
	32.0	23.6	NA	SM	90.0	231.8	NA	AZ
	0.0	0.0	NA	SM	85.0	157.9	NA	AZ
	0.0	0.0	NA	SM	87.0	181.0	NA	AZ
	2.0	0.0	NA	SM				
	5.4	3.4			83.7	161.4		
	11.2	8.3			5.9	56.3		
*=mixed fibers								
Average	5.4	3.4			83.7	161.4		
St. Dev.	11.2	8.3			5.9	56.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW6	1.0	0.0	NA	LA*	34.0	22.2	NA	SM*
	10.0	4.3	NA	LA*	40.0	27.8	NA	SM*
	0.0	0.0	NA	CR*	94.0	378.1	NA	LA*
	3.8	0.0	NA	CR*	87.0	804.6	NA	LA*
					87.7	190.7	NA	CR*
					88.0	195.2	NA	CR*
					100.0	#NUM!	NA	AZ
*=mixed fibers					100.0	#NUM!	NA	AZ
					100.0	#NUM!	NA	AZ
					100.0	#NUM!	NA	AZ
					79.0	113.4	NA	AZ
					82.0	#NUM!		
Average	3.7	1.1			82.0	#NUM!		
St. Dev.	4.5	2.2			24.7	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW7	84.0	#NUM!	NA	AZ*	69.8	76.8	NA	JL
	87.0	#NUM!	NA	AZ*	89.5	221.4	NA	JL
	17.2	9.9	NA	LA*	79.5	116.2	NA	JL
	16.6	9.4	NA	LA*	68.5	73.1	NA	JL
	57.0	79.1	NA	SM*	67.6	70.7	NA	SVB
					69.2	75.1	NA	SVB
					70.6	79.2	NA	SVB
					76.2	99.6	NA	SVB
					63.0	60.1	NA	AZ*
					55.0	46.0	NA	AZ*
*=mixed fibers					11.1	4.1	NA	LA*
					42.0	29.8	NA	SM*
					63.5	79.3		
Average	52.4	#NUM!			63.5	79.3		
St. Dev.	34.4	#NUM!			20.3	53.7		

## Diluted

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW3	50.5	55.9	1:50	SVB	0.0	0.0	1:50	JL
	34.5	26.6	1:50	SVB	4.2	0.0	1:50	JL
	16.0	8.9	1:50	SVB	0.0	0.0	1:50	JL
	31.7	23.3	1:50	SVB	13.3	5.9	1:50	JL
	0.0	0.0	1:50	JL	9.0	2.3	1:50	SVB
	17.0	9.7	1:50	JL	11.1	4.1	1:50	SVB
	0.0	0.0	1:50	JL	18.8	10.1	1:50	SVB
	0.0	0.0	1:50	JL	30.5	19.2	1:50	SVB
					10.9	5.2		
					10.3	6.7		
Average	18.7	15.5			10.9	5.2		
St. Dev.	18.9	19.3			10.3	6.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW4	2.0	0.0	1:150	LA*	11.0	4.1	1:150	LA*
	2.0	0.0	1:150	LA*	11.0	4.1	1:150	LA*
	0.0	0.0	1:150	CR*	4.2	0.0	1:150	CR*
	1.7	0.0	1:150	CR*	4.2	0.0	1:150	CR*
	0.0	0.0	1:150	SM	5.0	0.0	1:150	AZ
	0.0	0.0	1:150	SM	5.0	0.0	1:150	AZ
	0.0	0.0	1:150	SM	0.0	0.0	1:150	AZ
	0.0	0.0	1:150	SM	6.0	0.0	1:150	AZ
					5.8	1.0		
					3.7	1.9		
Average	0.7	0.0			5.8	1.0		
St. Dev.	1.0	0.0			3.7	1.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW5					27.7	16.9	1:10	IB
					22.3	12.7	1:10	IB
					22.4	12.8	1:10	IB
					24.9	14.7	1:10	IB
					29.8	18.6	1:10	IB
					28.9	17.8	1:10	IB
					26.7	16.1	1:10	IB
					23.4	13.6	1:10	IB
					25.8	15.4		
					2.9	2.3		
Average					25.8	15.4		
St. Dev.					2.9	2.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW6					48.4	37.0	1:10	IB
					40.7	28.5	1:10	IB
					47.2	35.6	1:10	IB
					54.7	45.6	1:10	IB
					56.5	48.3	1:10	IB
					56.7	48.6	1:10	IB
					52.3	42.1	1:10	IB
					46.2	34.4	1:10	IB
					50.3	40.0		
					5.7	7.3		
Average					50.3	40.0		
St. Dev.					5.7	7.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW7	84.8	#NUM!	1:2	CR*	94.1	384.4	1:2	CR*
	90.5	#NUM!	1:2	CR*	63.2	60.5	1:2	CR*
	75.0	3337.7	1:2	SM	70.0	77.4	1:2	AZ
	74.0	847.3	1:2	SM	68.0	71.8	1:2	AZ
	71.0	305.4	1:2	SM	67.0	69.2	1:2	AZ
	77.0	#NUM!	1:2	SM	71.0	80.4	1:2	AZ
	86.0	#NUM!	1:2	LA*	61.0	56.1	1:2	LA*
	85.0	#NUM!	1:2	LA*	55.0	46.0	1:2	LA*
					68.7	105.7		
					11.5	113.2		
Average	80.4	#NUM!			68.7	105.7		
St. Dev.	7.0	#NUM!			11.5	113.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW9	13.0	6.6	1:2	SM	21.4	12.0	1:200	JL
	0.0	0.0	1:2	SM	27.3	16.6	1:200	JL
	0.0	0.0	1:2	SM	36.5	24.4	1:200	JL
	0.0	0.0	1:2	SM	28.4	17.5	1:200	JL
	0.1	0.0	1:2	CR*	0.0	0.0	1:200	SVB
	2.2	0.0	1:2	CR*	0.0	0.0	1:200	SVB
					0.0	0.0	1:200	SVB
					0.0	0.0	1:200	SVB
					16.2	10.1		
					15.8	10.1		
Average	2.6	1.1			16.2	10.1		
St. Dev.	5.2	2.7			15.8	10.1		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW10	0.0	0.0	1:10	CR*	66.0	66.8	1:10	CR*
	0.0	0.0	1:10	CR*	59.0	52.5	1:10	CR*
	0.0	0.0	1:10	SM	96.0	574.9	1:10	AZ
	0.0	0.0	1:10	SM	96.0	574.9	1:10	AZ
	0.0	0.0	1:10	SM	96.0	574.9	1:10	AZ
	0.0	0.0	1:10	SM	95.0	454.0	1:10	AZ
	0.0	0.0	1:10	CR*	55.6	46.9	1:10	CR*
*mixed fibers	0.0	0.0	1:10	CR*	57.6	50.1	1:10	CR*
Average	0.0	0.0			77.7	299.4		
St. Dev.	0.0	0.0			19.6	265.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW8	30.0	21.4	NA	LA*	79.5	116.2	NA	SVB
	28.0	19.3	NA	LA*	92.2	293.3	NA	SVB
	100.0	#NUM!	NA	SM	93.0	325.4	NA	SVB
	12.0	5.8	NA	SM	86.2	171.0	NA	SVB
	0.0	0.0	NA	SM	85.0	157.9	NA	LA*
	31.0	22.5	NA	SM	83.0	139.9	NA	LA*
	9.4	3.8	NA	CR*	96.0	574.9	NA	AZ
	12.9	6.5	NA	CR*	98.0	1470.2	NA	AZ
	0.0	0.0	NA	JL	81.0	125.4	NA	AZ
	0.0	0.0	NA	JL	98.0	1470.2	NA	AZ
	0.0	0.0	NA	JL	92.7	312.5	NA	CR*
	0.0	0.0	NA	JL	80.9	124.7	NA	CR*
	0.0	0.0	NA	SVB	94.9	444.9	NA	JL
	2.3	0.0	NA	SVB	89	211.9	NA	JL
	2.6	0.0	NA	SVB	81.0	125.4	NA	JL
*=mixed fibers	14.1	7.4	NA	SVB				
Average	15.1	#NUM!			88.7	404.2		
St. Dev.	25.3	#NUM!			6.7	452.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW9	0.0	0.0	NA	AZ*	0.0	0.0	NA	SM*
	0.0	0.0	NA	AZ*	75.0	94.6	NA	AZ*
	10.0	4.3	NA	LA*	67.0	69.2	NA	AZ*
	13.0	6.6	NA	LA*	85.0	157.9	NA	LA*
	35.9	28.3	NA	SVB				
	34.0	26.0	NA	SVB				
	32.6	24.3	NA	SVB				
	35.3	27.6	NA	SVB				
	5.0	0.0	NA	JL				
	0.0	0.0	NA	JL				
	4.6	0.0	NA	JL				
	2.8	0.0	NA	JL				
*=mixed fibers								
Average	14.4	9.8			56.8	80.4		
St. Dev.	15.3	12.6			38.5	65.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW10	2.2	0.0	NA	LA*	98.5	2953.6	NA	LA*
	3.8	0.0	NA	LA*	98.0	1470.2	NA	AZ*
	2.0	0.0	NA	AZ*	88.0	195.2	NA	AZ*
	4.0	0.0	NA	AZ*	98.1	1620.6	NA	SM*
	0.0	0.0	NA	SM*	100.0	#NUM!	NA	SM*
	0.0	0.0	NA	SM*				
*=mixed fibers								
Average	2.0	0.0			96.5	#NUM!		
St. Dev.	1.7	0.0			4.8	#NUM!		

#### Diluted

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW3					41.7	29.5	1:10	IB
					39.9	27.6	1:10	IB
					36.9	24.8	1:10	IB
					39.2	27.0	1:10	IB
					51	40.3	1:10	IB
					50.9	40.2	1:10	IB
					48.9	37.6	1:10	IB
					45.7	33.9	1:10	IB
Average					44.3	32.6		
St. Dev.					5.6	6.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW4					23.0	13.2	1:100	JL
					25.7	15.3	1:100	JL
					26.4	15.9	1:100	JL
					27.5	16.7	1:100	JL
					46.0	34.2	1:100	SVB
					50.7	39.9	1:100	SVB
					51.6	41.1	1:100	SVB
					50.9	40.2	1:100	SVB
*=mixed fibers								
Average					37.7	27.1		
St. Dev.					13.1	12.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW6					17.9	9.4	1:150	SVB
					4.8	0.0	1:150	SVB
					12.8	5.5	1:150	SVB
					96.2	608.5	1:150	SVB
					94.5	412.2	1:150	JL
					14.0	6.5	1:150	JL
					5.2	0.0	1:150	JL
					27.4	16.7	1:150	JL
*=mixed fibers								
Average					34.1	132.3		
St. Dev.					38.5	239.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW7	21.4	13.3	1:50	SVB				
	24.0	15.6	1:50	SVB				
	24.3	15.8	1:50	SVB				
	15.8	8.8	1:50	SVB				
	22.0	13.8	1:50	JL				
	30.4	21.8	1:50	JL				
	44.8	42.5	1:50	JL				
	26.3	17.7	1:50	JL				
*=mixed fibers								
Average	26.1	18.7						
St. Dev.	8.6	10.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW9	0.0	0.0	1:100	LA*	19.0	10.2	1:100	LA*
	0.0		1:100	LA*	13.0	5.7	1:100	LA*
	0.0		1:100	CR*	20.9	11.7	1:100	CR*
	0.0		1:100	CR*	20.5	11.4	1:100	CR*
					72.0	83.6	1:100	AZ
					76.0	98.7	1:100	AZ
					72.0	83.6	1:100	AZ
					68.0	71.8	1:100	AZ
*=mixed fibers								
Average	0.0				45.2	47.1		
St. Dev.	0.0				28.9	40.6		

**SUBASE Bangor, Fiber, TNT and RDX, BTW samples**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BTW1	6.0	0.9	NA	CR*	8.7	2.0	NA	CR*
	6.4	1.3	NA	CR*	7.6	0.7	NA	CR*
	1.0	0.0	NA	LA*	25.0	14.8	NA	LA*
	0.0	0.0	NA	LA*	10.0	3.2	NA	LA*
	0.0	0.0	NA	SM	34.0	22.2	NA	AZ
	17.0	9.7	NA	SM	27.0	16.3	NA	AZ
	13.0	6.6	NA	SM	32.0	20.4	NA	AZ
	*=mixed fibers				45.0	33.0	NA	AZ
Average	6.2	2.7			23.7	14.1		
St. Dev.	6.7	3.9			13.7	11.4		

**SUBASE Bangor, Fiber, TNT and RDX, Standards**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TNT 100	61.4	105.1	NA	AZ *	20.9	11.7	NA	AZ*
	68.0	192.2	NA	AZ *	0.0	0.0	NA	AZ*
	49.0	51.9	NA	LA *	18.0	9.5	NA	LA*
	49.0	51.9	NA	LA *	0.0	0.0	NA	CR*
	0.0	0.0	NA	CR *	6.0	0.0	NA	SM*
	23.8	15.4	NA	SM *	0.0	0.0	NA	SM*
	0.0	0.0	NA	AZ *				
	*=mixed fibers							
Average	35.9	59.5			7.5	3.5		
St. Dev.	28.1	69.3			9.6	5.5		

**SUBASE Bangor, Fiber, TNT and RDX, Blanks**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BLANK 1	0.0	0.0	NA	SM	0.0	0.0	NA	AZ
	0.0	0.0	NA	SM	0.0	0.0	NA	AZ
	0.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	0.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	3.4	0.0	NA	CR*	4.0	0.0	NA	LA*
	0.0	0.0	NA	CR*	9.0	2.3	NA	LA*
	*=mixed fibers				0.0	0.0	NA	CR*
					0.0	0.0	NA	CR*
Average	0.6	0.0			1.6	0.3		
St. Dev.	1.4	0.0			3.3	0.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BLANK 2	3.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	1.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	0.0	0.0	NA	CR*	22.0	12.5	NA	AZ
	0.0	0.0	NA	CR*	0.0	0.0	NA	AZ
	0.0	0.0	NA	SM	8.0	1.2	NA	LA*
	0.0	0.0	NA	SM	2.0	0.0	NA	LA*
	*=mixed fibers				6.0	0.0	NA	CR*
					0.0	0.0	NA	CR*
Average	0.7	0.0			4.8	1.7		
St. Dev.	1.2	0.0			7.6	4.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BLANK 3	0.0	0.0	NA	CR*	6.0	0.0	NA	CR*
	0.3	0.0	NA	CR*	1.3	0.0	NA	CR*
	0.0	0.0	NA	LA*	0.0	0.0	NA	LA*
	0.0	0.0	NA	LA*	0.0	0.0	NA	LA*
	0.0	0.0	NA	SM	0.0	0.0	NA	AZ
	0.0	0.0	NA	SM	5.0	0.0	NA	AZ
	0.0	0.0	NA	SM	8.0	1.2	NA	AZ
	*=mixed fibers				5.0	0.0	NA	AZ
Average	0.0	0.0			3.2	0.2		
St. Dev.	0.1	0.0			3.2	0.4		



## Bangor RDX Flow Immunosensor EW samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew2_710						(ppb)						(ppb)	(ppb)	
	ew2_1	36	210	9184	RDX	105	124	8.9	7.20%		N	356	124	-97%
	ew2_2	35	252	11135	RDX	128								
	ew2_3	33	201	11180	RDX	128								
	ew2_4	35	208	11017	RDX	126								
	ew2_5	36	227	10429	RDX	119								
	ew2_6	37	252	11221	RDX	129								
	ew2_7	38	204	10058	RDX	115								
RDX100_3 = 8731														
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew2_78						(ppb)						(ppb)	(ppb)	
	ew2_1	335	150	12197	RDX	140	116	36	31%					
	ew2_2	36	127	11764	RDX	135								
	ew2_3	37	143	5397	RDX	62								
	ew2_4	36	151	11054	RDX	127								
	ew2_5	35	140	-226	RDX									
	rdx100_3	40	150	8731.3	RDX	Used as std.								
	rdx100_4	22	243	18574	RDX									
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew2_79						(ppb)						(ppb)	(ppb)	
	rdx100_1	30	150	78156	RDX									
	rdx100_2	22	440	21817	RDX									
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew3_78						(ppb)						(ppb)	(ppb)	
	ew3_1	42	116	8193	RDX	63	77	8.4	11%	0.26	N	496	77	-146%
	ew3_2	25	141	10135	RDX	78								
	ew3_3	34	149	10687	RDX	82								
	ew3_4	33	149	11606	RDX	89								
	ew3_5	34	149	10517	RDX	81								
	ew3_6	37	149	9099	RDX	70								
	ew3_7	39	149	9977	RDX	77								
	rdx100_3	38	151	13022	RDX	Used as std.								
	rdx100_2	40	150	7670	RDX									
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew4_77						(ppb)						(ppb)	(ppb)	
	ew4_1	34	111	1973	RDX	21	64	29	45%	0.216	N	261	64	-121%
	ew4_2	33	127	3534	RDX	37								
	ew4_3	33	138	4352	RDX	46								
	ew4_4	20	173	7289	RDX	77								
	ew4_5	23	197	8315	RDX	87								
	ew4_6	21	199	7953	RDX	84								
	ew4_7	23	197	9016	RDX	95								
	rdx100_1	22	188	9518	RDX	Used as std.								
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew5_77						(ppb)						(ppb)	(ppb)	
	ew5_1	16	306	7287	RDX	388	345.29	55.17				186	345	60%
	ew5_2	15	307	5069	RDX	270								
	ew5_3	17	308	7075	RDX	377								
	ew5_4	17	302	5076	RDX	271								
	ew5_5	19	301	6575	RDX	351								
	ew5_6	17	310	6562	RDX	350								
	ew5_7	18	308	7683	RDX	410								
	100rdx_1	44	305	1876	RDX	used as std.								
	1krdx_1	21	306	34742	RDX									
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew6_77						(ppb)						(ppb)	(ppb)	
	10_1	15	28	674	RDX		315	204	65%	0.12	N	419	315	-28%
	100_1	23	309	5912	RDX	Used as std.								
	ew6_1	12	262	13831	RDX	234								
	ew6_2	19	252	13770	RDX	233								
	ew6_3	28	310	25566	RDX	433								
	ew6_4	48	310	35474	RDX	600								
	ew6_5				RDX									
	ew6_6	93	306	4378	RDX	74								
	ew6_7	20	250	159	RDX	2.6								

[illegible]

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
bet1_78						(ppb)						(ppb)	(ppb)	
	bet1_1	81	151	4690	RDX	57.50	25.51	16.30	44%	0.69	Y	6.91	25.51	115%
	bet1_2	60	123	2000	RDX	24.5								
	bet1_3	69	131	1270	RDX	15.5								
	bet1_4	4	56	2865	RDX	35.1								
	bet1_5	25	59	1763	RDX	21.6								
	bet1_6	25	60	831	RDX	10.1								
	bet1_7	15	60	1773	RDX	14.3								
	10rdx1	108	139	695	RDX									
	100rdx1	23	114	10001	RDX									
	100rdx2	38	124	8149	RDX	Used as std.								

[illegible]

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
9/10/97 CHP RDX														
	1kdx_1.dat	35	298	44442	RDX	1000ng/ml								
	03c03_1.dat	38	296	19636	RDX	-								
	03c03_2.dat	38	295	21938	RDX	-								
	03c03_3.dat	36	296	21456	RDX	-								
	10dx1_1.dat	35	291	18412	RDX	100ng/ml								
	03c03_4.dat	36	295	24514	RDX	-								
	03c03_5.dat	38	298	22363	RDX	1000ng/ml								
	1kdx_2.dat	37	298	45848	RDX	1000ng/ml								
	03c03_6.dat	36	296	23344	RDX	-								
	03c03_7.dat	37	297	24971	RDX	-								
	1kdx_3.dat	35	298	48350	RDX	1000ng/ml								
	10dx2_2.dat	37	280	16699	RDX	100ng/ml								
	10dx_1.dat	34	213	2917	RDX	10ng/ml								
Sample														
9/10/97 PRG RDX	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
	rxn100_1.dat	42	113	11915	RDX	100ng/ml								
	rxn1_1.dat	80	197	497	RDX	-								
	spring_2.dat	49	146	8236	RDX	-								
	spring_3.dat	51	162	6258	RDX	-								
	rxn10_1.dat	38	62	415	RDX	10ng/ml								
	rxn1k_1.dat	38	273	36530	RDX	1000ng/ml								
	spring_6.dat	43	170	2858	RDX	-								
	spring_7.dat	34	198	13941	RDX	-								
	rxn100_1.dat	38	249	1989	RDX	100ng/ml								
	03c_10_1.dat	51	192	6052	RDX	-								
	03c_10_2.dat	53	183	5251	RDX	-								
	rxn1000_2.dat	38	254	15945	RDX	100ng/ml								
	03c_10_4.dat	54	184	3870	RDX	-								
	03c_10_5.dat	51	159	6320	RDX	-								
	03c_10_6.dat	48	131	1764	RDX	-								
	03c_10_7.dat	53	151	2673	RDX	-								
Sample														
9/10/97 CHP RDX	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
	1kdx_1.dat	25	279	90362	RDX	1000ng/ml								
	03c08_1.dat	n/a	n/a	none(?)	RDX	-								
	03c08_2.dat	n/a	n/a	none(?)	RDX	-								
	03c08_3.dat	73	129	1051	RDX	-								
	10dx_1.dat	39	221	5739	RDX	10ng/ml								
	10dx_2.dat	44	269	8129	RDX	10ng/ml								
	03c08_6.dat	68	211	8620	RDX	-								
	03c08_7.dat	69	231	10230	RDX	-								
	10dx10_1.dat	50	298	59462	RDX	1000ng/ml								
	10-8_1.dat	n/a	n/a	none(?)	RDX	-								
	10-8_2.dat	n/a	n/a	none(?)	RDX	-								
	10-8_3.dat	n/a	n/a	none(?)	RDX	-								
	10dx3_3.dat	43	299	8640	RDX	10ng/ml								
	10-8_4.dat	n/a	n/a	none(?)	RDX	-								
	10-8_5.dat	n/a	n/a	none(?)	RDX	-								
	10dx4_4.dat	61	223	4549	RDX	10ng/ml								
	10-8_6.dat	n/a	n/a	none(?)	RDX	-								
	10-8_7.dat	n/a	n/a	none(?)	RDX	-								
	10-8_8.dat	63	294	6613	RDX	10ng/ml								
	10c37_3.dat	n/a	n/a	none(?)	RDX	-								
	10c37_4.dat	n/a	n/a	none(?)	RDX	-								
	10c37_5.dat	n/a	n/a	none(?)	RDX	-								
	10dx7_7.dat	70	193	3454	RDX	10ng/ml								
	10c37_6.dat	n/a	n/a	none(?)	RDX	-								
	10c37_7.dat	n/a	n/a	none(?)	RDX	-								
	10dx_8.dat	73	215	6802	RDX	10ng/ml								
rxn1000.dat														
	03c12_1.dat	35	213	37375	RDX	1000ng/ml								
	10dx_1.dat	38	50	285	RDX	-								
	03c12_2.dat	37	51	303	RDX	-								
	03c12_3.dat	37	55	497	RDX	-								
	10dx10_1.dat	38	76	1288	RDX	1000ng/ml								
	03c12_4.dat	38	80	817	RDX	-								
	03c12_5.dat	37	75	812	RDX	-								
	10dx_1.dat	44	75	163	RDX	10ng/ml								
	03c12_6.dat	38	90	897	RDX	-								
	03c12_7.dat	38	76	833	RDX	-								
	10dx2_2.dat	38	100	1122	RDX	1000ng/ml								
	10-07_1.dat	38	80	585	RDX	-								
	10-07_2.dat	34	86	664	RDX	-								
	10-07_3.dat	40	87	561	RDX	-								
	10-07_7.dat	38	80	427	RDX	-								
	10dx_2.dat	52	84	76	RDX	10ng/ml								
	rxn1000_1.dat	36	207	44980	RDX	1000ng/ml								
	10-17_1.dat	38	69	616	RDX	-								
	10-17_2.dat	36	94	1899	RDX	-								
	10-17_3.dat	36	92	1763	RDX	-								
	10dx10_1.dat	37	164	8342	RDX	1000ng/ml								
	10-17_4.dat	37	93	1774	RDX	-								
	10-17_5.dat	32	94	2187	RDX	-								
	10dx_1.dat	33	71	633	RDX	10ng/ml								
	10-17_6.dat	35	105	1975	RDX	-								
	10-17_7.dat	38	89	1885	RDX	-								
9/11/97 HC/PRG RDX														
	10dx10n1.dat	17	98	1585	RDX	10ng/ml								
	rxn1n1.dat	17	52	208	RDX	1ng/ml								
	03c04r_1.dat	n/a	n/a	none	RDX	-								
	03c04r_2.dat	n/a	n/a	none	RDX	-								
	03c04r_3.dat	n/a	n/a	none	RDX	-								
	03c04r_4.dat	n/a	n/a	none	RDX	-								
	03c04r_6.dat	n/a	n/a	none	RDX	-								
	03c04r_7.dat	n/a	n/a	none	RDX	-								
	rxn100n3.dat	42	486	16393	RDX	1000ng/ml								
	rxn10n2.dat	21	67	292	RDX	10ng/ml								
Sample														
9/11/97 HC/PRG RDX NEW MEMBRANE	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
	rxn100n1.dat	43	199	22931	RDX	1000ng/ml								
	10c55_1.dat	23	258	27998	RDX	-								
	10c55_2.dat	22	304	32257	RDX	-								
	10c55_3.dat	21	353	40500	RDX	-								
	1000n1_2.dat	14	338	59698	RDX	1000ng/ml								
	10c55_6.dat	21	223	14044	RDX	-								
	10c55_7.dat	17	263	14762	RDX	-								
	1000n1_3.dat	16	374	56400	RDX	1000ng/ml								
	100dx_2.dat	44	286	11656	RDX	1000ng/ml								
	10dx_1.dat	25	51	224	RDX	10ng/ml								
	1rdx_1.dat	24	80	128	RDX	1ng/ml								
10/09/97 CHP RDX RUN AT NRL														
	1kdx_1.dat	39	193	11249	RDX	1000ng/ml								
	1kdx_2.dat	35	208	14110	RDX	1000ng/ml								
	10c57r_3.dat	35	61	1086	RDX	-								
	1kdx_3.dat	36	300	18788	RDX	1000ng/ml								
	10c57r_4.dat	37	55	619	RDX	-								
	10c57_6.dat	35	56	624	RDX	-								
	10c57_7.dat	36	61	925	RDX	-								
	10dx_1.dat	33	179	1123	RDX	10ng/ml								
	10dx_2.dat	36	157	962	RDX	10ng/ml								
	10c55r_1.dat	29	190	3431	RDX	-								
	10c55_2.dat	35	162	2608	RDX	-								
	10c55r_3.dat	34	224	3842	RDX	-								
	100dx_2.dat	39	283	8738	RDX	1000ng/ml								
	10c55r_5.dat	38	169	4362	RDX	-								
	100dx_3.dat	41	297	9268	RDX	1000ng/ml								
	100dx_4.dat	45	298	14719	RDX	1000ng/ml								
	03-34r_1.dat	42	133	1226	RDX	-								
	03-34r_2.dat	33164	1262	rdx	-									
	03-34r_3.dat	41	164	1262	RDX	-								
	100dx_6.dat	36	228	4208	RDX	1000ng/ml								
	03-34r_4.dat	41	149	1200	RDX	-								
	03-34r_5.dat	43	170	602	R									

**Detection of Explosives (TNT Immunoassay)**

Bangor SUBASE, Manchester, WA

Flow Immunosensor, TNT, EW samples

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew2						(ppb)						(ppb)	(ppb)	
	ew2_1	35	78	246	TNT	49	49	9.1	18.50%			24	49	68%
	ew2_2	33	71	215	TNT	42								
	ew2_3	37	88	306	TNT	60								
	ew2_4	33	75	326	TNT	64								
	ew2_5	37	73	226	TNT	45								
	ew2_6	35	69	208	TNT	45								
	ew2_7	36	74	225	TNT	44								
	100tnt_1	43	90	506	TNT	std. used								
	100tnt_2	45	105	169	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew3						(ppb)						(ppb)	(ppb)	
	ew3_1	16	62	1552	TNT	104	168	35.6	21.20%			263	168	-44%
	ew3_2	37	145	2499	TNT	168								
	ew3_3	36	115	2576	TNT	173								
	ew3_4	34	118	2508	TNT	159								
	ew3_5	33	137	2453	TNT	165								
	ew3_6	36	131	2551	TNT	171								
	ew3_7	39	138	3373	TNT	227								
	100ppb	38	137	2551	TNT	n/a								
	1000ppb	1045	139	1488	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew4						(ppb)						(ppb)	(ppb)	
	ew4_1	35	50	110	TNT	62	57	19.8	34.60%			0.068	57	200%
	ew4_2	35	55	128	TNT	72								
	ew4_3	37	51	91	TNT	51								
	ew4_4	41	62	122	TNT	69								
	ew4_5	41	55	60	TNT	34								
	ew4_6	33	58	148	TNT	83								
	ew4_7	40	58	53	TNT	30								
	tnt10_1	36	76	270	TNT	n/a								
	std100_7	39	100	178	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew5						(ppb)						(ppb)	(ppb)	
	ew5_1	37	56	539	TNT	44	13	5.8	45%	0.61	Y	0.057	13	198%
	ew5_2	37	55	216	TNT	18								
	ew5_3	34	57	270	TNT	22								
	ew5_4	36	48	114	TNT	9								
	ew5_5	21	47	132	TNT	11								
	ew5_6	29	48	115	TNT	9								
	ew5_7	32	51	98	TNT	8								
	std100_1	36	136	1237	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew6						(ppb)						(ppb)	(ppb)	
	ew6_1	37	91	566	TNT	76	45	18.2	40.90%			n/a	45	n/a
	ew6_2	37	105	452	TNT	61								
	ew6_3	33	83	344	TNT	46								
	ew6_4	38	61	190	TNT	26								
	ew6_5	34	63	304	TNT	41								
	ew6_6	35	64	242	TNT	33								
	ew6_7	31	63	216	TNT	29								
	std100_1	36	117	742	TNT	std. used								
	std100_2	37	95	409	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew7						(ppb)						(ppb)	(ppb)	
	ew7_1	42	146	18309	TNT	2184	1608	303.9	18.90%			977	1608	49%
	ew7_2	41	150	15502	TNT	1849								
	ew7_3	41	148	12749	TNT	1521								
	ew7_4	39	150	10973	TNT	1308								
	ew7_5	40	149	9236	TNT	1520								
	ew7_6	38	150	8758	TNT	1446								
	ew7_7	41	151	8668	TNT	1427								
	1ktnt_1	39	147	8384	TNT	std. used 1-4								
	1ktnt_2	40	149	60075	TNT	std. used 5-7								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew8						(ppb)						(ppb)	(ppb)	
	ew8_1	40	77	671	TNT	62	79	15				0.073	79	200%
	ew8_2	34	90	943	TNT	88								
	ew8_3	33	110	946	TNT	88								
	ew8_4	37	93	568	TNT	53								
	ew8_5	33	112	963	TNT	90								
	ew8_6	39	103	875	TNT	81								
	ew8_7	39	103	943	TNT	88								
	100tnt_3	33	126	1075	TNT	std. used								
	100tnt_4	40	119	598	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew9						(ppb)						(ppb)	(ppb)	
	ew9_1	43	100	311	TNT		690	427.9	62%			n/a	690	n/a
	ew9_2	38	60	111	TNT									
	ew9_3	38	111	929	TNT									
	ew9_4	33	110	612	TNT									
	ew9_5	37	119	1432	TNT									
	ew9_6	33	120	808	TNT									
	ew9_7	32	95	608	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
ew10						(ppb)						(ppb)	(ppb)	
	ew10_1	39	77	372	TNT	24	39	21.6	56.10%	0.93	Y	n/a	39	n/a
	ew10_2	36	76	369	TNT	24								
	ew10_3	42	72	280	TNT	18								
	ew10_4	42	99	1054	TNT	68								
	ew10_5	42	100	976	TNT	63								
	ew10_6	98	145	11987	TNT	773								
	ew10_7	34	80	523	TNT	34								
	100	44	117	1550	TNT	std. used								
	1000	35	89	1990	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
inf_1						(ppb)						(ppb)	(ppb)	
	inf_1	34	58	233	TNT	15	16	2.8	17.30%			1.9	16	158%
	inf_2	36	64	223	TNT	15								
	inf_3	35	62	201	TNT	13								
	inf_4	24	62	264	TNT	17								
	inf_5	34	65	196	TNT	13								
	inf_6	39	72	300	TNT	20								
	inf_7	35	73	283	TNT	19								
	10tnt_3	45	93	133	TNT	n/a								
	10tnt_4	41	107	152	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
eff1_714						(ppb)						(ppb)	(ppb)	
	eff1_1	35	60	316	TNT	BDL	91	12	13.30%	0.77	Y	n/a	91	n/a
	eff1_2	35	60	78	TNT	BDL								
	eff1_3	35	60	80	TNT	BDL								
	eff1_4	35	60	105	TNT	BDL								
	eff1_5	35	82	102	TNT	BDL								
	eff1_6	35	60	82	TNT	BDL								
	eff1_7	35	52	97	TNT	BDL								
	blk_1	35	60	43	TNT	BDL								

Bangor SUBASE  
TNT, flow, fls samples

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-1 1ppb TNT	1_1	35	82	1487		1	1	0.14	15.70%			0.96	1	-4.08%
	1_1_11b3	21	60	244	TNT	n/a								
	1_1	35	110	1459	TNT	std. used								
	1_2_11b3	36	81	158	TNT	n/a								
	1_4	35	120	1175	TNT	1								
	1_4_11b3	23	62	95	TNT	n/a								
	1_5	35	107	1522	TNT	1								
	1_5_11b3	30	80	62	TNT	n/a								
	1_6	36	92	1262	TNT	0.8								
	1_6_11b3	32	65	47	TNT	n/a								
	1_7	37	109	1021	TNT	0.7								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-2 10ppb TNT	fls2_1	38	78	484	TNT	37	15	12.1	19.40%			7.64	15	-65.02%
	fls2_2	36	66	ND	TNT									
	fls2_3	38	77	144	TNT	11								
	fls2_4	40	73	99	TNT	8								
	**fls2_5	41	82	132	TNT	10								
	fls2_6	40	87	164	TNT	12								
	fls2_7	38	76	114	TNT	9								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-3 100ppb TNT	fls3_1	36	78	926	TNT	std. used	105	52.6				91.1	105	-14.18%
	fls3_2	45	113	1512	TNT	163								
	fls3_3	44	138	1499	TNT	162								
	fls3_4	48	125	542	TNT	59								
	fls3_5	46	106	720	TNT	78								
	fls3_6	45	108	576	TNT	62								
	fls3_7	41	113	461	TNT	50								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls_3 blank	blnk_1	33	119	10538	TNT	21								
	blnk_2	84	126	1642	TNT	6								
	blnk_3	83	109	1541	TNT	11								
	100tnt_1	38	281	51306	TNT	std. for 1								
	100tnt_2	77	279	28808	TNT	std. for 2								
	100tnt_3	41	199	14345	TNT	std. for 3								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-4 1000ppb TNT	fls4_1	33	151	5219	TNT	3318	965	1102.6	114.30%			960	965	1%
	fls4_2	35	150	4331	TNT	2753								
	fls4_3	41	116	1573	TNT	std. used								
	fls4_4	37	134	1570	TNT	998								
	fls4_5	32	144	2004	TNT	1274								
	fls4_6	13	108	1488	TNT	946								
	fls4_7	43	132	1008	TNT	641								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-5 5000ppb TNT	fls5_1	33	114	1971	TNT	3638	4097	1717.9	41.90%			5230	4097	-24%
	fls5_2	38	139	2075	TNT	3830								
	fls5_3	41	150	3071	TNT	5668								
	fls5_4	39	142	1754	TNT	3237								
	fls5_5	37	139	2709	TNT	std. used								
	fls5_6	37	150	3510	TNT	6478								
	fls5_7	38	97	938	TNT	1731								

## NOT USED

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-5 5000 ppb TNT	5000_1	30	271	23544	TNT	9964	6201	5137	78.10%					
	***5000_2	42	270	11815	TNT	5000								
	5000_3	22	247	7839	TNT	3317								
	5000_4	21	297	8747	TNT	3702								
	5000_5	24	311	35437	TNT	14997								
	5000_6	19	212	5603	TNT	2371								
	5000_7	26	283	6750	TNT	2857								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-11 TNB 100ppb	100_1	40	149	3468	TNT		1877.4	850.6	45.30%			-	1877.4	-
	100_2	40	148	2534	TNT									
	100_3	41	149	1930	TNT									
	100_4	40	146	1479	TNT									
	100_5	40	151	1291	TNT									
	100_6	40	149	1293	TNT									
	100_7	41	147	1147	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-12														

100 DNT	100_1	44	93	490	TNT	160	95	32.2	33.90%			-	95	-	
	100_2	38	101	349	TNT	114									
	100_3	42	96	240	TNT	78									
	100_4	45	101	306	TNT	std. used									
	100_5	43	109	217	TNT	71									
	100_6	42	110	216	TNT	71									
	100_7	40	105	264	TNT	86									
	100_8	36	106	259	TNT	85									
fls-13	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
		fls13_1	43	72	889	TNT	84	48.6	31.3	64.40%			n/a	48.6	n/a
		fls13_2	40	78	873	TNT	83								
		fls13_3	35	84	661	TNT	63								
		fls13_4	42	77	278	TNT	26								
		fls13_5	34	73	133	TNT	13								
		fls13_6	33	81	130	TNT	12								
		fls13_7	24	113	624	TNT	59								
		100tnt_1	44	120	1052	TNT	std. used								
		100tnt_2	35	137	1153	TNT	n/a								
fls-14	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
		fls14_1	40	148	5396	TNT	std. used	99.7	39.2	39.40%			97	99.7	3%
		fls14_2	33	150	7775	TNT	144								
		fls14_3	34	151	8132	TNT	151								
		fls14_4	45	150	5413	TNT	100								
		fls14_5	43	149	3849	TNT	71								
		fls14_6	41	151	3457	TNT	64								
		fls14_7	38	150	3692	TNT	68								
fls-15	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
TNT, 2,4-DNT		fls15_1	36	79	880	TNT		558	204.3	36.60%			92.5	558	143%
100ppb		fls15_2	36	104	764	TNT									
		fls15_3	37	76	599	TNT									
		fls15_4	36	72	501	TNT									
		fls15_5	35	75	444	TNT									
		fls15_6	37	80	417	TNT									
		fls15_7	36	74	300	TNT									
fls-16	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
		fls16_1	43	96	359	TNT		112.1	13.4	12%			92	112.1	20%
		fls16_2	40	124	617	TNT									
		fls16_3	36	104	412	TNT									
		fls16_4	34	110	484	TNT									
		fls16_5	30	116	316	TNT									
		fls16_6	33	102	392	TNT									
		fls16_7	35	111	534	TNT									
fls-17	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
100 mix		100_1	35	148	1827	TNT	1007	111.9	11.1				94.1	111.8	17%
TNT,TNB, 2,4 DNT		100_2	43	150	1101	TNT									
100ppb		100_3	45	149	1149	TNT									
		100_4	45	148	1006	TNT									
		100_5	43	145	861	TNT									
		100_6	47	149	1027	TNT									
		100_7	51	149	898	TNT									
fls-18	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
100 mix b		100_1	47	149	5877	TNT		2996.6	1579.5	52.70%			86.8	2996.6	189%
TNT,TNB,2 amino-DNT		100_2	47	148	4134	TNT									
100ppb		100_3	44	147	2906	TNT									
		100_4	56	149	2007	TNT									
		100_5	42	141	2930	TNT									
		100_6	40	148	1925	TNT									
		100_7	43	97	1197	TNT									
fls-21	Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
100 TNT/RDX		100_1	38	113	526	TNT		379.1	101.5	26.80%			94.1	379.1	120%
100ppb		100_2	46	148	305	TNT									
		100_3	46	150	375	TNT									
		100_4	41	146	336	TNT									
		100_5	46	143	399	TNT									
		100_6	48	148	231	TNT									
		100_7	38	139	482	TNT									

## Bangor SUBASE

## Flow Immunosensor, TNT, bet samples

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
bet1						(ppb)						(ppb)	(ppb)	
	bet1_1	43	106	115	TNT	BDL	BDL	BDL				n/a	BDL	n/a
	bet1_2	40	106	-121	TNT	BDL								
	bet1_3	40	100	-16	TNT	BDL								
	bet1_4	40	100	128.2	TNT	BDL								
	bet1_5	40	100	24.1	TNT	BDL								
	bet1_6	40	100	20	TNT	BDL								
	bet1_7	40	100	-19	TNT	BDL								
	tnt10_1	40	100	-59	TNT	BDL								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc.	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330	FAST 2000	RPD
bet2						(ppb)						(ppb)	(ppb)	
	bet2_1	35	80	0	TNT	BDL	BDL			0.62	Y	n/a	BDL	n/a
	bet2_2	33	73	176	TNT	3.7								
	bet2_3	33	70	421	TNT	8.9								
	bet2_4	33	67	359	TNT	7.6								
	bet2_5	33	66	420	TNT	8.9								
	bet2_6	32	70	400	TNT	8.5								
	bet2_7	36	68	367	TNT	7.8								

Crane Field Trial (September 8-12, 1997)  
Fiber, TNT and RDX, Numbered samples

03C samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C03P2	-24.5	0.0	NA	KD	102.0	#NUM!	NA	LA
	-11.6	0.0	NA	KD	95.0	454.0	NA	LA
	4.3	0.0	NA	KD	89.2	215.6	NA	IB
	-3.4	0.0	NA	KD	75.0	94.6	NA	IB
	-59.0	0.0	NA	KD	72.4	84.9	NA	IB
	-65.0	0.0	NA	KD	72.0	53.6	NA	IB
	-96.0	0.0	NA	KD				
Average	-36.5	0.0			84.3	#NUM!		
St. Dev.	37.4	0.0			12.9	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C03P2					58.4	51.5	NA	LA
					46.0	34.2	NA	LA
					44.4	32.4	NA	IB
					52.5	42.4	NA	IB
Average					50.3	40.1		
St. Dev.					6.4	8.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C04	-176.7	0.0	NA	KD	-9.0	0.0	NA	TM
	-168	0.0	NA	KD	-4.0	0.0	NA	TM
	-68.6	0.0	NA	KD	4.0	0.0	NA	KD
	22.0	13.8	NA	LA	6.5	0.0	NA	KD
	12.0	5.8	NA	LA	3.7	0.0	NA	KD
	34.0	26.0	NA	LA	16.7	8.5	NA	KD
	1.0	0.0	NA	TM	-70.0	0.0	NA	IB
	-69.3	0.0	NA	TM	-100.0	0.0	NA	IB
	-7.2	0.0	NA	TM	-88.0	0.0	NA	IB
	-53.2	0.0	NA	TM	-92.0	0.0	NA	IB
	12.1	5.9	NA	TM	-83.9	0.0	NA	SVB
	-46.9	0.0	NA	TM				
	-7.7	0.0	NA	TM				
	-40.2	0.0	NA	TM				
	15.9	8.8	NA	TM				
Average	-10.6	5.0			-37.8	0.9		
St. Dev.	33.6	8.0			47.8	2.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C08AP2	5.6	0.5	NA	TM	47.3	35.7	NA	TM
	11.9	5.8	NA	TM	48.0	36.5	NA	TM
	9.6	4.0	NA	TM	70.8	79.8	NA	LSL
	10.8	4.9	NA	TM	80.5	122.1	NA	LSL
	-11.2	0.0	NA	KD	71.0	80.4	NA	LSL
	2.4	0.0	NA	KD	59.9	54.1	NA	SVB
	-11.7	0.0	NA	KD	53.0	43.1	NA	SVB
	-30.2	0.0	NA	TM	38.3	26.1	NA	SVB
	-18.7	0.0	NA	TM	43.8	31.7	NA	SVB
	-20.7	0.0	NA	TM				
	-7.3	0.0	NA	TM				
Average	-5.4	1.4			57.0	56.6		
St. Dev.	14.4	2.3			14.4	31.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C09P2					47.0	35.3	NA	IB
					59.0	52.5	NA	IB
					63.2	60.5	NA	SVB
					53.4	43.6		
					51.5	41.0		
					46.0	34.2		
					53.3	43.5		
Average					53.3	44.4		
St. Dev.					6.1	9.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C10	12.0	5.8	NA	LA	44.0	31.9	NA	KD
	-35.0	0.0	NA	LA	74.0	90.7	NA	KD
	-28.0	0.0	NA	LA	67.0	69.2	NA	KD
	20.1	12.2	NA	TM	48.0	36.5	NA	KD
	-24.7	0.0	NA	TM	74.9	94.2	NA	TM
	-11.2	0.0	NA	TM	60.3	54.8	NA	TM
	-32.1	0.0	NA	TM	51.2	40.6	NA	LA
					48.4	37.0	NA	IB
					25.0	14.8	NA	IB
					57.6	50.1	NA	IB
					59.7	53.7	NA	IB
					33.8	22.0	NA	SVB
Average	-14.1	2.6			53.7	49.6		
St. Dev.	22.1	4.8			15.1	24.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C12	16.7	9.5	NA	TM				
	-60.9	0.0	NA	TM				
	-39.9	0.0	NA	TM				
	-103.7	0.0	NA	TM				
	-161.0	0.0	NA	KD				
	-142.0	0.0	NA	KD				
	-109.0	0.0	NA	KD				
	-55.0	0.0	NA	KD				
Average	-61.9	1.2						
St. Dev.	58.2	3.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C17	-70.8	0.0	NA	TM	-19.0	0.0	NA	IB
	-15.7	0.0	NA	TM	16.4	8.3	NA	SVB
	-64.4	0.0	NA	TM	6.2	0.0	NA	SVB
	14.0	7.4	NA	TM	4.3	0.0	NA	IB
	-50.5	0.0	NA	KD	-3.2	0.0	NA	IB
	-51.5	0.0	NA	KD	14.6	6.9	NA	IB
	-57.4	0.0	NA	KD				
	-54.5	0.0	NA	KD				
Average	-43.9	0.9			3.2	2.5		
St. Dev.	28.5	2.6			13.0	3.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03-34	-92.0	0.0	NA	KD	-0.8	0.0	NA	IB
	-99.0	0.0	NA	KD	-0.3	0.0	NA	IB
	-27.1	0.0	NA	TM	-0.6	0.0	NA	IB
	14.9	8.1	NA	TM	6.3	0.0	NA	IB
	-13.6	0.0	NA	TM				
	23.2	14.8	NA	TM				
	-73.0	0.0	NA	JL				
	-136.0	0.0	NA	JL				
	-71.0	0.0	NA	JL				
Average	-52.5	2.5			1.2	0.0		
St. Dev.	54.5	5.3			3.4	0.0		

10- samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10-07	-75.4	0.0	NA	KD	14.0	6.5	NA	IB
	-88.4	0.0	NA	KD	24.0	14.0	NA	IB
	-36.9	0.0	NA	KD	29.9	18.7	NA	SVB
	-45.0	0.0	NA	KD				
	-41.0	0.0	NA	KD				
	-38.2	0.0	NA	KD				
	19.6	11.8	NA	TM				
	17.8	10.3	NA	TM				
	21.0	12.9	NA	TM				
	0.0	0.0	NA	TM				
Average	-26.7	3.5			22.6	13.1		
St. Dev.	39.5	5.7			8.0	6.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10-08	14.9	8.1	NA	TM	-12.0	0.0	NA	IB
	-11.6	0.0	NA	TM	-0.9	0.0	NA	IB
	0.7	0.0	NA	TM	-1.6	0.0	NA	IB
	-41.9	0.0	NA	TM	-1.0	0.0	NA	IB
	-170.9	0.0	NA	KD	-55.6	0.0	NA	SVB
	-129.7	0.0	NA	KD				
	-116.9	0.0	NA	KD				
	-174.0	0.0	NA	KD				
	0.0	0.0	NA	LA				
	0.0	0.0	NA	LA				
	-60.0	0.0	NA	LA				
Average	-62.7	0.7			-14.2	0.0		
St. Dev.	72.4	2.4			23.6	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10-17	30.5	21.9	NA	TM	-18.0	0.0	NA	LSL
	32.0	23.6	NA	TM	40.0	27.8	NA	LSL
	31.5	23.0	NA	TM	33.0	21.3	NA	LSL
	21.6	13.5	NA	TM	8.0	1.2	NA	LSL
	19.0	11.3	NA	TM	34.0	22.2	NA	SVB
	44.1	41.2	NA	TM	20.0	11.0	NA	SVB
	29.5	20.9	NA	TM	-23.0	0.0	NA	IB
	53.7	65.8	NA	TM	-87.0	0.0	NA	IB
	32.0	23.6	NA	KD	-27.0	0.0	NA	IB
	23.6	16.2	NA	KD	14.7	7.0	NA	SVB
	31.6	23.2	NA	KD				
	26.5	17.9	NA	KD				
Average	31.3	25.1			-0.5	9.0		
St. Dev.	9.5	14.9			39.0	10.9		



## 10C samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C37	-53.3	0.0	NA	KD	-50.0	0.0	NA	IB
	-82.2	0.0	NA	KD	-39.0	0.0	NA	IB
	-48.7	0.0	NA	KD	-69.0	0.0	NA	IB
	-50.7	0.0	NA	TM	-38.0	0.0	NA	IB
	3.0	0.0	NA	TM	-122.4	0.0	NA	SVB
	-41.5	0.0	NA	TM	-56.0	0.0	NA	IB
	16.8	9.5	NA	TM	-51.0	0.0	NA	IB
					-56.0	0.0	NA	IB
					-47.0	0.0	NA	IB
Average	-36.7	1.4			-58.7	0.0		
St. Dev.	34.5	3.6			25.7	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C55	8.5	3.1	NA	LA	68.0	71.8	NA	IB
	0.0	0.0	NA	LA	59.4	53.2	NA	SVB
	5.0	0.0	NA	LA	59.4	53.2	NA	SVB
	25.0	16.5	NA	LA	56.0	47.5	NA	IB
	28.0	19.3	NA	LA	71.0	80.4	NA	IB
	9.0	3.5	NA	LA	86.0	168.7	NA	IB
	0.0	0.0	NA	LA	79.0	113.4	NA	IB
	-60.0	0.0	NA	LA				
	-32.4	0.0	NA	KD				
	-15.0	0.0	NA	KD				
	6.6	1.5	NA	KD				
	-25.2	0.0	NA	KD				
Average	-4.2	3.7			68.4	84.0		
St. Dev.	26.1	6.8			11.1	43.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C55P2	24.1	15.6	NA	KD	30.6	19.3	NA	IB
	10.0	4.3	NA	LA	29.0	18.0	NA	IB
	10.0	4.3	NA	LA	27.0	16.3	NA	SVB
	1.0	0.0	NA	LA	13.3	5.9	NA	IB
	-26.0	0.0	NA	LA	7.9	1.1	NA	IB
					-6.0	0.0	NA	IB
					31.9	20.4	NA	IB
Average	3.8	4.9			19.1	11.6		
St. Dev.	18.6	6.4			14.4	8.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C57	-10.0	0.0	NA	LA	0.4	0.0	NA	IB
	-40.0	0.0	NA	LA	0.0	0.0	NA	SVB
	-30.0	0.0	NA	LA	-0.3	0.0	NA	SVB
	-30.0	0.0	NA	LA				
	-103.3	0.0	NA	KD				
	-142.4	0.0	NA	KD				
	-122.9	0.0	NA	KD				
Average	-68.4	0.0			0.0	0.0		
St. Dev.	53.0	0.0			0.3	0.0		

## 1x ppb TNT samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
1 ppb TNT	-0.5	0.0	NA	KD	-4.6	0.0	NA	IB
(new)	-13.2	0.0	NA	KD	-2.2	0.0	NA	IB
	-42.3	0.0	NA	KD	3.9	0.0	NA	IB
	-23.8	0.0	NA	KD	-16.0	0.0	NA	IB
	-30.0	0.0	NA	JSL				
	-44.0	0.0	NA	JSL				
	-29.0	0.0	NA	JSL				
	-25.0	0.0	NA	JSL				
Average	-26.0	0.0						
St. Dev.	14.3	0.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10 ppb TNT	-4.0	0.0	NA	LSL				
(old)	-4.0	0.0	NA	LSL				
	10.0	4.3	NA	LSL				
	14.0	7.4	NA	LSL				
	21.0	12.9	NA	KD				
	10.2	4.5	NA	KD				
	13.0	6.6	NA	KD				
	6.1	2.8	NA	KD				
Average	8.5	4.8						
St. Dev.	8.7	4.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10 ppb TNT	53.9	66.5	NA	KD				
(new)	50.8	56.7	NA	KD				
	71.0	305.4	NA	KD				
	55.5	72.6	NA	KD				
	33.0	24.8	NA	JSL				
	32.0	23.6	NA	JSL				
	29.0	20.4	NA	JSL				
	-17.0	0.0	NA	TM				
	-11.7	0.0	NA	TM				
	-14.5	0.0	NA	TM				
	25.9	17.3	NA	TM				
	43.3	39.7	NA	KD				
	42.9	39.0	NA	KD				
	39.9	34.0	NA	KD				
	47.6	48.5	NA	KD				
	30.0	21.4	NA	LA				
	13.0	6.6	NA	LA				
	-10.0	0.0	NA	LA				
	-80.0	0.0	NA	LA				
Average	22.9	40.9						
St. Dev.	35.8	68.1						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
100 ppb TNT	54.2	67.6	NA	TM	-0.1	0.0	NA	IB
(new)	65.3	144.2	NA	TM	4.5	0.0	NA	IB
	62.0	109.8	NA	TM	4.6	0.0	NA	IB
	64.4	133.0	NA	TM	0.4	0.0	NA	IB
	71.2	318.2	NA	TM				
	68.2	197.0	NA	TM				
	68.4	202.1	NA	TM				
	55.4	72.2	NA	TM				
	50.1	54.7	NA	TM				
	43.0	39.2	NA	TM				
	39.8	33.9	NA	TM				
	33.6	25.5	NA	TM				
Average	56.3	116.4			2.4	0.0		
St. Dev.	12.4	87.8			2.5	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
1000 ppb TNT	39.5	33.4	1:10	KD	-2.6	0.0	NA	IB
(new)	45.4	43.7	1:10	KD	1.2	0.0	NA	IB
	51.3	58.1	1:10	KD	-1.7	0.0	NA	IB
	36.4	29.0	1:10	KD	-4.6	0.0	NA	IB
	39.0	32.7	1:10	JSL				
	31.0	22.5	1:10	JSL				
	40.0	34.2	1:10	JSL				
	49.0	51.9	1:10	JSL				
Average	41.5	38.2			-1.9	0.0		
St. Dev.	6.7	12.0			2.4	0.0		



**1x ppb RDX samples**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10 ppb RDX					27.9	17.1	NA	TM
					-98.7	0.0	NA	TM
Average					-35.4	8.5		
St. Dev.					89.5	12.1		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
100 ppb RDX					57.0	49.1	NA	LA
					39.0	26.8	NA	LA
					69.0	74.5	NA	KD
					77.0	103.2	NA	KD
					70.3	78.3	NA	KD
Average					62.5	66.4		
St. Dev.					15.0	29.3		

**Spring samples**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
Spring	5.0	0.0	NA	LSL	31.0	19.8	NA	LA
	9.0	3.5	NA	LSL	62.0	58.1	NA	LA
	18.0	10.5	NA	LSL	64.0	62.2	NA	LA
	25.0	16.5	NA	LSL	39.0	26.8	NA	IB
	-21.0	0.0	NA	LSL	36.0	24.0	NA	IB
	-25.0	0.0	NA	LSL	35.0	23.1	NA	IB
	2.0	0.0	NA	LSL				
	13.0	6.6	NA	LSL				
	-6.0	0.0	NA	JL				
	1.3	0.0	NA	JL				
	20.2	12.3	NA	JL				
	28.4	19.8	NA	JL				
	11.0	5.1	NA	KD				
	-19.0	0.0	NA	KD				
	30.2	21.6	NA	KD				
	24.3	15.8	NA	KD				
Average	7.3	7.0			44.5	35.6		
St. Dev.	17.7	7.9			14.6	19.2		

**Detection of Explosives (RDX Immunoassay)**

CraneNSWC

Date: September 6, 1997

Crane RDX Flow Immunosensor, Numbered samples

**03C samples**

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c03	03c03_1.dat	38	296	19636	RDX	442	504	35				678	504	-29%
	03c03_2.dat	38	295	21938	RDX	494								
	03c03_3.dat	36	296	21456	RDX	482								
	03c03_4.dat	36	295	24514	RDX	552								
	03c03_5.dat	38	298	22363	RDX	503								
	03c03_6.dat	36	296	23344	RDX	509								
	03c03_7.dat	37	297	24971	RDX	545								
	10rdx_1.dat	34	213	2917	RDX	10								
	100rdx_1.dat	35	291	18412	RDX	100								
	100rdx_2.dat	37	260	16699	RDX	100								
	1krdx_1.dat	35	298	44442	RDX	1000								
	1krdx_2.dat	37	298	45848	RDX	1000								
	1krdx_3.dat	35	298	48350	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c04	03c04r_1.dat	n/a	n/a	none	RDX	BDL	BDL	BDL				n/a	BDL	n/a
	03c04r_2.dat	n/a	n/a	none	RDX	BDL								
	03c04r_3.dat	n/a	n/a	none	RDX	BDL								
	03c04r_4.dat	n/a	n/a	none	RDX	BDL								
	03c04r_5.dat	n/a	n/a	none	RDX	BDL								
	03c04r_6.dat	n/a	n/a	none	RDX	BDL								
	03c04r_7.dat	n/a	n/a	none	RDX	BDL								
	rdx1n1.dat	17	52	208	RDX	1								
	rdx10n1.dat	17	98	1585	RDX	10								
	rdx10n2.dat	21	67	292	RDX	10								
	rdx100n2.dat	34	374	21585	RDX	100								
	rdx100n3.dat	42	486	16393	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c08	03c08_1.dat	n/a	n/a	none	RDX	BDL	11.2	4.7				126	11	-168%
	03c08_2.dat	n/a	n/a	none	RDX	BDL								
	03c08_3.dat	73	129	1051	RDX	11.6								
	03c08_4.dat	69	166	2993	RDX	5.2								
	03c08_5.dat	68	187	4341	RDX	7.6								
	03c08_6.dat	68	211	8620	RDX	14								
	03c08_7.dat	69	231	10230	RDX	16.7								
	10rdx_1.dat	39	221	5739	RDX	10								
	10rdx_2.dat	44	269	6129	RDX	10								
	1krdx_1.dat	25	279	90362	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c09	03c09r_1.dat	42	100	5575	RDX	467	483	62				146	483	107%
	03c09r_2.dat	41	134	5536	RDX	464								
	03c09r_3.dat	41	128	5792	RDX	485								
	03c09r_4.dat	41	169	7283	RDX	610								
	03c09r_5.dat	42	162	5929	RDX	497								
	03c09r_6.dat	41	180	5255	RDX	440								
	03c09r_7.dat	41	200	4977	RDX	417								
	10rdx_3.dat	41	150	1363	RDX	10								
	1krdx_4.dat	41	126	7344	RDX	1000								
	1krdx_5.dat	41	209	11941	RDX	1000								
	1krdx_6.dat	41	257	15105	RDX	1000								
	1krdx_7.dat	40	271	13339	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c10	03c_10_1.dat	51	192	6052	RDX	145	104	41				121	104	-15%
	03c_10_2.dat	53	183	5251	RDX	126								
	03c_10_4.dat	54	184	3870	RDX	93								
	03c_10_5.dat	51	159	6320	RDX	152								
	03c_10_6.dat	48	131	1764	RDX	42								
	03c_10_7.dat	53	151	2673	RDX	64								
	rdx100_1.dat	38	249	1989	RDX	100								
	rdx100_3.dat	37	181	13860	RDX	100								
	rdx1000_2.dat	38	204	15945	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c12	03c12_1.dat	38	50	285	RDX	7.6	17	7				25.6	17	-40%
	03c12_2.dat	37	51	303	RDX	8.1								
	03c12_3.dat	37	55	497	RDX	13.2								
	03c12_4.dat	38	80	817	RDX	22								
	03c12_5.dat	37	75	812	RDX	22								
	03c12_6.dat	38	90	897	RDX	24								
	03c12_7.dat	38	76	833	RDX	22								
	10rdx_1.dat	44	75	183	RDX	10								
	100rdx_1.dat	38	76	1288	RDX	100								
	100rdx_2.dat	38	100	1122	RDX	100								
	rdx1000.dat	35	213	37575	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03_34	03-34r_1.dat	42	133	1226	RDX	29	23.08	9.80				41	23	-56%
	03-34r_2.dat	33	164	1262	RDX	30								
	03-34r_3.dat	41	164	1262	RDX	30								
	03-34r_4.dat	41	149	1200	RDX	28								
	03-34r_5.dat	43	170	602	RDX	14								
	03-34r_6.dat	38	121	319	RDX	7.5								
	100rdx_4.dat	45	298	14719	RDX	100								
	100rdx_5.dat	36	228	4226	RDX	100								
	100rdx_6.dat	37	249	4379	RDX	100								

#### 10\_samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10_07	10-07_1.dat	38	80	585	RDX	52	54	6.2				28.6	54	62%
	10-07_2.dat	34	86	664	RDX	59								
	10-07_3.dat	40	87	561	RDX	50								
	10-07_6.dat	37	98	565	RDX	62.3								
	10-07_7.dat	38	80	427	RDX	47								
	10rdx_2.dat	52	84	76	RDX	10								
	100rdx_3.dat	39	112	906	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10_08	10-8_1.dat	n/a	n/a	none	RDX	BDL	BDL	-				23.8	BDL	BDL
	10-8_2.dat	n/a	n/a	none	RDX	BDL								
	10-8_3.dat	n/a	n/a	none	RDX	BDL								
	10-8_4.dat	n/a	n/a	none	RDX	BDL								
	10-8_5.dat	n/a	n/a	none	RDX	BDL								
	10-8_6.dat	n/a	n/a	none	RDX	BDL								
	10-8_7.dat	n/a	n/a	none	RDX	BDL								
	10rdx_3.dat	43	299	8640	RDX	10								
	10rdx_4.dat	61	223	4549	RDX	10								
	100rdx_1.dat	50	298	59462	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10_17	10-17_1.dat	38	69	616	RDX	13.6	31.63	16.51				35.2	32	-10%
	10-17_2.dat	36	94	1899	RDX	42								
	10-17_3.dat	36	92	1793	RDX	39.8								
	10-17_4.dat	37	93	1774	RDX	37.4								
	10-17_5.dat	32	94	218	RDX	2.6								
	10-17_6.dat	35	105	1975	RDX	44								
	10-17_7.dat	38	89	1885	RDX	42								
	10rdx_1.dat	33	71	633	RDX	10								
	100rdx_1.dat	37	164	8342	RDX	100								
	100rdx_2.dat	n/a	n/a	n/a	RDX	100								
	rdx1000_1.dat	36	207	44980	RDX	1000								



**Detection of Explosives (TNT Immunoassay)**

Crane NSW

Date: September 6, 1997

Flow Immunosensor, Numbered samples

**03c samples**

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03co3	03co3_1.dat	n/a	n/a	nothing	TNT	BDL	BDL			4.27	BDL	BDL
	03co3_2.dat	n/a	n/a	none	TNT	BDL						
	03co3_3.dat	n/a	n/a	none	TNT	BDL						
	03co3_4.dat	n/a	n/a	none	TNT	BDL						
	03co3_5.dat	n/a	n/a	none	TNT	BDL						
	03co3_6.dat	n/a	n/a	none	TNT	BDL						
	03co3_7.dat	n/a	n/a	none	TNT	BDL						
	03co3_8.dat	n/a	n/a	none	TNT	BDL						
	10tnt_1.dat	17	43	316	TNT	10						
	10tnt_2.dat	15	49	253	TNT	10						
	1ktnt.dat	25	63	1298	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03co4	03co4_1.dat	n/a	n/a	nothing	TNT	BDL	BDL			n/a	BDL	n/a
	03co4_2.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_3.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_4.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_5.dat	n/a	n/a	none	TNT	BDL						
	03co4_6.dat	n/a	n/a	none	TNT	BDL						
	03co4_7.dat	n/a	n/a	none	TNT	BDL						
	tnt100n.dat	38	86	1811	TNT	100						
	tnt100n2.dat	n/a	n/a	none?	TNT	100						
	tnt100n3.dat	33	115	467	TNT	100						
	tnt100n4.dat	39	112	296	TNT	100						
	tnt1000n.dat	33	172	2995	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c08	03c08_1.dat	19	27	29	TNT	4.9	14	9.4	68%	n/a	14.0	n/a
	03c08_2.dat	16	28	63*	TNT	10.8						
	03c08_3.dat	18	27	38	TNT	6.5						
	03c08_4.dat	18	26	32	TNT	5.5						
	03c08_5.dat	11	30	161	TNT	27.5						
	03c08_6.dat	n/a	n/a	no response	TNT	BDL						
	03c08_6.dat	18	32	99	TNT	16.9						
	03c08_7.dat	17	34	146	TNT	24.9						
	10tnt_7.dat	8	34	59	TNT	10						
	100tnt_1.dat	21	(1)43	230(1030)	TNT	100						
	100tnt_2.dat	20	86	586	TNT	100 **						
	100tnt_3.dat	15	98	371	TNT	100						

\* there was a sharp peak at the beginning

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c09	03c09_1.dat (P2)	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	03c09_2.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_3.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_4.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_5.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_6.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_7.dat (P2)	n/a	n/a	none	TNT	BDL						
	10tnt_7.dat	38	85	792	TNT	10						
	10tnt_8.dat (P2)	38	84	480	TNT	10						
	1ktnt_2.dat	39	111	11413	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c10	03c10_1.dat	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	03c10_2.dat	n/a	n/a	none	TNT	BDL						
	03c10_3.dat	n/a	n/a	none	TNT	BDL						
	03c10_4.dat	n/a	n/a	none	TNT	BDL						
	03c10_5.dat	n/a	n/a	none	TNT	BDL						
	03c10_6.dat	n/a	n/a	none	TNT	BDL						
	03c10_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_8.dat	21	48	73	TNT	10						
	10tnt_9.dat	20	61	97	TNT	10						
	10tnt_10.dat	19	40	396	TNT	10						
	1ktnt_2.dat	18	87	3692	TNT	1000						



## 10c samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c37	10c37_1.dat	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	10c37_2.dat	n/a	n/a	none	TNT	BDL						
	10c37_3.dat	n/a	n/a	none	TNT	BDL						
	10c37_4.dat	n/a	n/a	none	TNT	BDL						
	10c37_5.dat	n/a	n/a	none	TNT	BDL						
	10c37_6.dat	n/a	n/a	none	TNT	BDL						
	10c37_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_18.dat	21	56	86	TNT	10						
	10tnt_17.dat	25	59	274	TNT	10						
	1tnt_1.dat	-	-	BDL	TNT	1						
	1tnt_2.dat	28	66	117	TNT	1						
	1ktnt_3.dat	22	73	1227	TNT	-						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c55R	10c55_1.dat (P2)	n/a	n/a	none	TNT	-	BAD MEM					
	10c55_2.dat (P2)	n/a	n/a	none	TNT	-						
	10c55_3.dat	n/a	n/a	none	TNT	-						
	10c55_4.dat	n/a	n/a	none	TNT	-						
	10c55_5.dat	n/a	n/a	none	TNT	-						
	10tnt_14.dat	17	46	265	TNT	10						
	10tnt_15.dat	20	36	141	TNT	10						
	10tnt_16.dat	21	48	164	TNT	10						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c55	10c55_1.dat	38	62	146	TNT	43	40.2	11.7	12%	50.8	40.0	-23.79%
	10c55_2.dat	36	65	159	TNT	46						
	10c55_3.dat	37	66	155	TNT	45						
	10c55_4.dat	35	64	123	TNT	34						
	10c55_5.dat	33	63	117	TNT	47						
	10c55_6.dat	31	70	161	TNT	47						
	10c55_7.dat	34	73	170	TNT	50						
	10tnt_3.dat	37	72	251	TNT	10						
	10tnt_4.dat	37	77	241	TNT	36						
	10tnt_5.dat	40	71	152	TNT	44						
	10tnt_6.dat	38	69	148	TNT	10						
	100tnt_1.dat	39	98	343	TNT	100 **						

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c57	10c57_1.dat	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	10c57_2.dat	n/a	n/a	none	TNT	BDL						
	10c57_3.dat	n/a	n/a	none	TNT	BDL						
	10c57_4.dat	n/a	n/a	none	TNT	BDL						
	10c57_5.dat	n/a	n/a	none	TNT	BDL						
	10c57_6.dat	n/a	n/a	none	TNT	BDL						
	10c57_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_9.dat (P2)	35	84	487	TNT	10						
	10tnt_10.dat	36	84	491	TNT	10						
	10tnt_11.dat	36	93	453	TNT	10						
	10tnt_12.dat	38	84	271	TNT	10						

## 10\_samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_07												
	10_07_1.dat	n/a	n/a	none	TNT	BDL	BDL	BDL		1.21	BDL	BDL
	10_07_2.dat	n/a	n/a	none	TNT	BDL						
	10_07_3.dat	n/a	n/a	none	TNT	BDL						
	10_07_4.dat	n/a	n/a	none	TNT	BDL						
	10_07_5.dat	n/a	n/a	none	TNT	BDL						
	10_07_6.dat	n/a	n/a	none	TNT	BDL						
	10_07_7.dat	n/a	n/a	none	TNT	BDL						
	tnt10n1.dat	35	80	83	TNT	10						
	tnt100n1.dat	34	87	1739	TNT	100						
	tnt100n2.dat	37	108	386	TNT	100						
	tnt100n3.dat	n/a	n/a	none	TNT	100						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_08												
	10-8_1.dat	n/a	n/a	none	TNT	BDL	5	2.8	57%	0.98	5	#####
	10-8_2.dat	14	26	42	TNT	1.5						
	10-8_3.dat	14	27	71	TNT	2.5						
	10-8_4.dat	17	29	111	TNT	4						
	10-8_5.dat	15	25	155	TNT	5.6						
	10-8_6.dat	18	32	200	TNT	7.2						
	10-8_7.dat	17	33	244	TNT	8.7						
	10tnt_11.dat	19	37	266	TNT	10						
	10tnt_12.dat	20	37	191	TNT	10						
	10tnt_14.dat	20	53	279	TNT	10 **						

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c17												
	03c17_1.dat	36	50	108*	TNT	3.6	7	3.1	43%	21.5	7	#####
	03c17_2.dat	35	53	297*	TNT	9.9						
	03c17_3.dat	34	50	255*	TNT	8.5						
	03c17_4.dat	33	47	100*	TNT	3						
	03c17_5.dat	n/a	n/a	none	TNT	BDL						
	03c17_6.dat	37	49	298*	TNT	9.1						
	03c17_7.dat	32	49	275*	TNT	9.1						
	tnt10n1	36	88	927	TNT	10						
	tntn3.dat	35	140	496	TNT	100						
	tnt100n1	39	101	3013	TNT	100 **						
	tnt100n2	37	123	1092	TNT	100						

\* there was a sharp peak at the beginning

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
Spring												
	spr_1.dat	36	60	385	TNT	94.6	115	16	#####	3.16	115	#####
	spr_2.dat	35	59	452	TNT	111						
	spr_3.dat	36	59	442	TNT	108.7						
	spr_4.dat	37	60	436	TNT	107						
	spr_5.dat	35	60	461	TNT	113.3						
	s1000.dat	38	102	1958	TNT	1000						
	spr_6.dat	36	62	569	TNT	139.8						
	spr_7.dat	35	62	539	TNT	132.4						
	tnt10_1.dat	38	98	505?	TNT	10						
	tnt100_1.dat	-	-	no response	TNT	100						
	std100_3.dat	37	89	407	TNT	100**						
	tnt100_4.dat	39	74	212	TNT	100						
	st1000_1.dat	35	115	1687	TNT	1000						

\*\* Standard used for Quantitation

# Soil extracts

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rpd
TJ001	1	20057.39	413	400	64	0.16	400	0	200
	2	17741.73	366						
	3	14750.98	304						
	4	18105.46	373						
	5	21332.53	514						
	6	17317.53	418						
	7	16999.57	410						
500_1		26823.72		24259					
500_2		21694.72		20740					
500_3		19784.38							

TJ002	1	21184.07	589	530	51	0.10	530	352	40
	2	18168.92	505						
	3	19250.53	536						
	4	16766.98	466						
	5	17116.73	569						
	6	17274.32	575						
	7	14037.36	467						
500_1		18850.87		17972					
500_2		17093.63		15032					
500_3		12970.46							

TJ003	1	4275.27	78	61	14	0.23	61	209	-110
	2	4104.02	75						
	3								
	4	3531.5	65						
	5	2661.76	49						
	6	2536.36	46						
	7	2779.64	51						
500_1		29004.4		27322					
500_2		25638.92		27385					
500_3		29131.53							

TJ004	1	1058.36	23	36	7	0.21	36	407	-167
	2	1630.41	36						
	3	1936.02	43						
	4	1502.26	33						
	5	1693.73	35						
	6	2199.43	46						
	7	1702.52	36						
500_1		23047.79		22706					
500_2		22364.08		23961					
500_3		25558.73							

TJ005	1	28802.6	759	598	123	0.21	598	50456	-195
	2	22814.75	601						
	3	21134.92	557						
	4	22483.51	592						
	5	2448.79	752						
	6	13629.39	419						
	7	16533.93	508						
500_1		21042.95		18981					
500_2		16918.9		16272					
500_3		15625.86							

TJ006 (1:10)	2	91066.88	1917	1329	424	0.32	13290	147985	-167
	3	73948.88	1557						
	4	82271.58	1732						
	6	39771.78	842						
	7	39996.36	847						
	8	52537.84	1112						
	9	69387.91	1298						
500_2		27006.79		23748					
500_3		20489.09		23614					
500_4		26738.72							

TJ007 (1:10)	2	29211.44	988	856	92	0.11	8560	8633	-1
	3	26727.92	906						
	4	27267.29	922						
	6	22210.87	797						
	7	21494.38	771						
	8	20390.48	732						
	9	24439.77	877						
500_1		26766.93		27861					
1000_2		29579.99							
1000_3		26142.05							

TJ008 (1:100)	2	26908.62	983	929	65	0.07	92900	138500	-39
	3	23296.85	851						
	4	25791.44	942						
	5	23091.1	844						
	6	26414.52	982						
	7	26075.06	969						
500_1		13682.95		13569					
500_2		13455.56							
500_3		35957.31							

TJ009	1	17784.44	352	365	37	0.10	365	526	-36
	2	21028.32	416						
	3	20259.61	401						
	4	19795.64	392						
	5	18920.98	336						
	6	18921.52	336						
	7	18274.62	324						
500_1		25455.83		25259					
500_2		25062.41		28189					
500_3		31315.65							

TJ003	1	1033.93	48.53	59	10	0.17	59	209	-112
	2	1301	51.13						
	3	1407.78	52.17						
	4	1556.39	53.62						
	5	2683.13	64.58						
	6	2610.45	63.88						
	7	3828.61	75.73						
100_		6322.286							
50_1		1184.736							

TJ004	1	4100.34	101.02	110	9	0.08	110	407	-115
	2	3909.92	96.33						
	3	5046.38	124.33						
	4	4389.22	108.14						
	5	4658.83	114.78						
	6	4513.18	111.19						
	7	4545.03	111.98						
100_1		11124.26							
100_2		4058.86							

TJ006 (1:100)	2*	1	24791.42	2451.9	1934	361	0.19	193400	147985	27
		2	14650.32	1488.93						
		3	20468.78	2024.39						
		4	21307.96	2107.38						
		5	23475.31	1932.55						
		6	19219.99	1582.24						
		7	18310.76	1507.39						
1000_4			10111.11							
1000_5			12147.32							

TJ010	1	52125.57	674	665	103	0.16	665	2818	-124
	2	58739.61	760						
	3	60863.67	787						
	4	50702.46	707						
	5	47978.05	670						
	6	39403.68	550						
	7	36328.18	507						
	500_1	36806.87		38669					
	500_2	40530.43		35808					
	500_3	31084.6							
	1000_1	35003.7							

G18-L3-A	2	47527.64	642	662	42	0.06	662	10259	-176
	3	48061.39	650						
	4	47233.83	638						
	5	54090.1	747						
	6	49485.42	684						
	7	44983.61	622						
	8	46870.09	648						
	500_1	34168.74		36996					
	500_2	39822.98		36181					
	500_3	32539.09							

G51-L1-A	1	55921.58	1506	1426	108	0.08	1426	2203	-43
	2	57013.43	1535						
	3	54460.73	1467						
	4	48085.32	1295						
	5	51837.23	1518						
	6	47423.65	1389						
	7	43494.89	1274						
	500_1	30110.89							
	1000_2	37130.34							
	1000_3	34145.8							

G55-X-A (1:100)	1	37759.71	762	744	130	0.17	74400	135885	-58
	2	35540.11	717	792	67	0.08			
	3	37321.43	753						
	4	40857.09	825						
	5	41936.2	785						
	6	24664.96	462						
	7	48451.51	907						
	500_1	25145.07		24770					
	500_2	24394.2		26704					
	500_3	29013.36							

G16-L2-A (1:100)	2	13472.12	315	368	35	0.10	36800	14850	85
	3	16074.68	376						
	4	14812.85	347						
	5	14561.14	360						
	6	17140.95	423						
	7	16165.11	399						
	8	14393.21	356						
	500_1	20628.34		21361					
	500_2	22093.57		20243					
	500_3	18393.38							

G18-L1-A (1:100)	2	31920.32	1448	897	264	0.29	80500	19492	122
	3	20756.26	942	805	114	0.14			
	4	19696.15	894						
	5	18562.8	624						
	6	22419.99	754						
	7	22960.55	772						
	8	25142.6	845						
	500_1	20108.13							
	1000_1	22041.72							
	1000_2	29752.89							

TJ010	1:10	1	5457.77	441.35	347	52	0.15	3470	2818	21
		2	3771.17	304.96						
		3	3796.39	307						
		4	3624.24	293.08						
		5	3367.96	376.22						
		6	3155.61	352.5						
		7	3175.01	354.67						
		500_1	6473.398		6183					
		500_2	5891.932		4476					
		500_3	3059.078							

G18-L3-A	1:20	3	5213.316	1278.46	811	238	0.29	16224.13	10259	45
		4	3333.406	817.45	718	72	0.10	14355	10259	33
		5	3142.101	770.54						
		6	4448.47	675.79						
		7	4396.979	667.97						
		8	4324.948	657.03						
		500_1	4077.803							
		500_2	6582.625							

G51-L1-A	1:10	1	31349.92	302.57	355	29	0.08	3550	2203	47
		2	38850.79	374.96						
		3	39399.96	380.26						
		4	35479.37	342.42						
		5	36551.95	372.07						
		6	47423.65							
		7	36826.41	355.42						
		500_1	49746.39		51807					
		1000_2	53866.93							

	ug/L	sd	vol	soil kg	cfi mg/kg	sd	hplc mg/kg
TJ001	400	64	25	0.005	2	2.86	0.46 <b>0.6</b>
TJ002	530	51	13.75	0.00275	2.65	3.7895	0.36 <b>2.6</b>
TJ003	59	10	25.25	0.00505	0.295	0.42185	0.07 <b>4.4</b>
TJ004	110	9	27.8	0.00556	0.55	0.7865	0.06 <b>bdl</b>
TJ005	598	123	25.15	0.00503	2.99	4.2757	0.88 <b>3.7</b>
TJ006	193400	36100	21.2	0.00424	967	1382.81	258.12 <b>1247.0</b>
TJ007	8560	920	25	0.005	42.8	61.204	6.58 <b>127.0</b>
TJ008	317000	13000	28.9	0.00579	1582.263	2262.635	92.79 <b>986.0</b>
TJ009	365	37	25	0.005	1.825	2.60975	0.26 <b>3.6</b>
TJ010	3470	520	27.05	0.00541	17.35	24.8105	3.72 <b>19.0</b>
G18-L3-A	14355	1440	25.25	0.00506	71.63315	102.4354	10.28
G51-L1-A	3550	290	25.1	0.00502	17.75	25.3825	2.07
G55-X-A	74400	13000	25.1	0.00502	372	531.96	92.95
G16-L2-A	36800	3500	25.25	0.00506	183.6364	262.6	24.98
G18-L1-A	80500	11400	25	0.005	402.5	575.575	81.51

114

2

-175

#VALUE!

-21

-25

-99

46

-65

-9

**Soil Samples 1-99** Fast 2000 from T. Jenkins (TJ) and Umatilla (Um)  
\*\*\*\*Standard Deviation of the samples is calculated from the original data

last printed 4-29-99

Sample	Area (AU)								
Criteria:	TNT	Conc.	avg	std	rsd	conc*dil	HPLC	RPD	
TJ 001-1	544	22	22		6	0.26	22 BDL	#VALUE!	
TJ 001-2	483	19							
TJ 001-3	826	33							
TJ 001-4	638	25							
TJ 001-5	595	24							
TJ 001-6	402	16							
TJ 001-7	419	17							
STD 100-2	2520	100							
STD 100-3 *ugly	1427								
STD 100-4	1514								

Sample	Area (AU)								
Criteria:	TNT	Concentration							
TJ 002-1	10979	584	367	113	0.31	367	551	-40	
TJ 002-2	7199	383							
TJ 002-3	7307	389							
TJ 002-4	6515	347							
TJ 002-5	4980	265							
TJ 002-6	6940	369							
TJ 002-7	4367	232							
STD 100-1	1879	100							
STD 1000-2	4493								
STD 1000-3	3850	looked funny							

Sample	Area (AU)								
Criteria:	TNT	Concentration							
TJ 003-1	98087	45385	17561	13348	0.76	17561	915965	-192	
TJ 003-2	39860	18443							
TJ 003-3	38086	17622							
TJ 003-4	37930	17550							
TJ 003-5	24690	11424							
TJ 003-6	14635	6772							
TJ 003-7	12380	5728							
STD 1000-1	2161	1000							
STD 1000-3	not pretty	3483							

Sample	Area (AU)								
Criteria:	TNT	Conc							
TJ 004-1	maxed out	5562	844	323	0.38	8442	49054	-141	
TJ 004-2 (1:10)	22592	1123							
TJ 004-3 (1:10)	25397	1262							
TJ 004-4 (1:10)	19303	959							
TJ 004-5 (1:10)	14534	722							
TJ 004-6 (1:10)	short run	538							
TJ 004-7 (1:10)	9289	461							
STD 100-1	2665								
STD 100-2	2012	100							
STD 1000-3	1402								

Sample	Area (AU)		Bright Yellow						
Criteria:	TNT	Conc							
TJ 005-1 (1:100)	8093	4802	3422	1156	0.34	342248	1205	199	
TJ 005-2 (1:100)	7495	4448							
TJ 005-3 (1:100)	6639	3940							
TJ 005-4 (1:100)	3788	2248							
TJ 005-5 (1:100)	3650	2166							
TJ 005-6 (1:100)	6913	4102							
TJ 005-7 (1:100)	3795	2252							
STD 1000-1	5858								
STD 1000-2 dip	1685	1000							
STD 1000-3 ugly	1530								
STD 1000-4	1577								

Sample	Area (AU)								
Criteria:	TNT	Conc							
TJ 006-1 maxed out	61049	35680	4616	1460	0.32	46160	82118	-56	
TJ 006-2 (1:10)	12763	7459							
TJ 006-3 (1:10)	7300	4266							
TJ 006-4 (1:10)	8135	4755							
TJ 006-5 (1:10)	6806	3978							
TJ 006-6 (1:10)	6418	3751							
TJ 006-7 (1:10)	5966	3487							
STD 100-1 blip -	564								
STD 1000-2 noisy	1711	1000							
STD 1000-3 ugly	1503								

Sample	Area (AU)								
Criteria:	TNT	Conc							
TJ 007-1 maxed out	60172	22949	1832	480	0.26	183166	251548	-31	
TJ 007-2 (1:10)	25537	9740							
TJ 007-3 (1:100)	2873	1096							
TJ 007-4 (1:100)	6398	2440							
TJ 007-5 (1:100)	4946	1886							
TJ 007-6 (1:100)	4761	1816							
TJ 007-7 (1:100)	5035	1920							
STD 100-1 steep baseline	939								
STD 1000-2	2622	1000							
STD 1000-3	1951								

Sample	Area (AU)								
Criteria:	TNT	Conc							
TJ 008-1	22842	12876	730	102	0.14	7301 BDL	#VALUE!		
TJ 008-2 (1:10)	1569	884							
TJ 008-3 (1:10)	1372	773							
TJ 008-4 (1:10)	1249	704							
TJ 008-5 (1:10)	1124	634							
TJ 008-6 (1:10)	1162	655							
STD 100-1	603								
STD 1000-2	1774	1000							
STD 1000-3 mtn-like	1136								

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rdp
TJ003	1	1270.93	727	1027	204	0.20	1027286	915965	11
(1:1000)	2	1860.86	1065						
	3	1708.2	977						
	4	1669.42	1308						
	5	1464.34	1148						
	6	1471.78	1153						
	7	1037.6	813						
	1000_5	2138.32	1748						
	1000_6	1357.43	1276						
	1000_7	1194.36							

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rdp
TJ004	3	3329.49	599	482	117	0.24	481714.3	49054	163
(1:1000)	4	2724.57	490						
	5	1877.42	338						
	6	1698.02	306						
	7	1620.49	598						
	8	1438.5	530						
	9	1385.47	511						
	500_1	4048.71	2778						
	500_3	1507.97	1356						
	500_5	1204.82							
	1000_2	4044.71	2884						
	1000_4	1722.92							

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rdp
TJ006	2	963.13	1322	963	313	0.32	963142.9	82118	169
(1:1000)	3	1040.49	1440						
	4	762.67	1017						
	5	632.93	820						
	6	607.79	826						
	7	466.4	616						
	8	523.84	701						
	500_2	422.64							
	500_5	388.41							
	1000_1	1458.31							
	1000_3	751.33							
	1000_4	724.9							

Sample	Area (AU)						
Criteria:	TNT	Conc					
TJ 009-1	20935	4246	142	10	0.07	14223	BDL #VALUE!
TJ 009-2 (1:10)	7117	1444					
TJ 009-3 (1:100) blip -	741	150					
TJ 009-4 (1:100)	709	144					
TJ 009-5 (1:100)	757	154					
TJ 009-6 (1:100)	633	128					
TJ 009-7 (1:100)	666	135					
STD 100-1	493	100					
STD 1000-3	1670						

Sample	Area (AU)						
Criteria:	TNT	Conc					
TJ 010-1	inconclusive						
TJ 010-2							
TJ 010-3							
TJ 010-4							
TJ 010-5							
TJ 010-6							
TJ 010-7							
STD 100-1							
STD 100-2							
STD 100-3							

Sample	Area (AU)						
Criteria:	TNT	Conc					
G-16-L2-A 1:10 1	16045	3134	2858	1051	0.37	28576	12797 76
G-16-L2-A 1:10 2	13626	2662					
G-16-L2-A 1:10 3	13224	2583					
G-16-L2-A 1:10 4	14711	2874					
G-16-L2-A 1:10 5 strange	12043	2353					
G-16-L2-A 1:10 6 strange	25202	4923					
G-16-L2-A 1:10 7 strange	7545	1474					
STD 100-1 ugly	1285						
STD 1000-2	5119	1000					
STD 1000-3	3347						

Sample	Area (AU)						
Criteria:	TNT	Conc					
G-51-L1-A 1:10 1 ugly	10220	2826	1601	672	0.42	16006	2660 143
G-51-L1-A 1:10 2 ugly	5612	1552					
G-51-L1-A 1:10 3 ugly	7642	2113					
G-51-L1-A 1:10 4	5067	1401					
G-51-L1-A 1:10 5	3402	941					
G-51-L1-A 1:10 6	5190	1435					
G-51-L1-A 1:10 7	3382	935					
STD 100-1 ugly	526						
STD 1000-2 ugly	6290						
STD 1000-3 std used	3616	1000					

Sample	Area (AU)						
Criteria:	TNT	Conc					
G-18-L1-A 1:10 1	17075	7030	3613	1845	0.51	72270	23482 102
G-18-L1-A 1:20 2	11812	4863					
G-18-L1-A 1:20 3	9708	3997					
G-18-L1-A 1:20 4	5795	2386					
G-18-L1-A 1:20 5	7318	3013					
G-18-L1-A 1:20 6	4872	2006					
G-18-L1-A 1:20 7 ugly	4860	2001					
STD 1000-1	4750	1000					
STD 1000-2	2429						

Sample	Area (AU)						
Criteria:	TNT	Conc					
G-55-X-A 1:100 1	6043	3475	2194	670	0.31	219363	231011 -5
G-55-X-A 1:100 2	4124	2371					
G-55-X-A 1:100 3	4100	2358					
G-55-X-A 1:100 4	3847	2212					
G-55-X-A 1:100 5	3272	1882					
G-55-X-A 1:100 6	2539	1460					
G-55-X-A 1:100 7	2778	1597					
STD 100-1 ugly	288						
STD 1000-2	1739	1000					
STD 1000-3	745						

Sample	Area (AU)						
Criteria:	TNT	Concentration					
G-18-L3 1	10944	3061	1799	325	0.18	17987	3698 132
G-18-L3 1:10 2	8245	2306					
G-18-L3 1:10 3	6929	1938					
G-18-L3 1:10 4	7031	1967					
G-18-L3 1:10 5	5489	1535					
G-18-L3 1:10 6	5460	1527					
G-18-L3 1:10 7	5428	1518					
STD 1000-1	1657						
STD 1000-2	3575	1000					
STD 1000-3	2303						

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rp
TJ010	2	3703.33	793		871	256	0.29	87085.71	434 198
(1:100)	3	3542.91	759						
	4	2192.4	469						
	5	3150.9	1243						
	6	2822.65	1114						
	7	1951.25	770						
	8	2401.09	948						
	500_1	3142.15		2335					
	500_2	1527.17		1267					
	500_4	1005.95							
	1000_3	1366.7							
	1000_5	1638.65							

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rp
G16-L2-A	1	239.5	136		272	160	0.59	27171.43	12797 72
(1:100)	2	344.52	196						
	3	476.12	271						
	4	543.32	309						
	5	292.89	166						
	6	380.87	216						
	7		608						
	500_1	713.36		880					
	500_2	1047.13							
	500_3								

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rp
G51-L1-A	1	4962.16	667		553	135	0.24	5534.286	2660 70
(1:10)	2	5132.48	690						
	3	4213.24	566						
	4	2231.45	300						
	5	4039.32	586						
	6	3148.8	457						
	7	4188.83	608						
	500_1	3219.31		3720					
	500_2	4220.25		3444					
	500_3	2667.25							

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rp
G18-L1-A	1	2420.69	565		506	63	0.12	50614.29	23482 73
(1:100)	2	2100.21	490						
	3	1842.01	430						
	4	2096.56	489						
	5	1716.92	563						
	6	1756.25	576						
	7	1311.53	430						
	500_1	2708.09		2143					
	500_2	1577.18		1524					
	500_3	1470.35							

Sample	#	integral	conc	avg	std	rsd	conc*dil	HPLC	rp
G18-L3-A	1	880.98	305		279	33	0.12	27857.14	3698 153
(1:100)	2	644.15	223						
	3	788.05	273						
	4	747.27	259						
	5	719.66	293						
	6	801.68	326						
	7	665.85	271						
	250_6	721.46							
	250_7	614.74							

**Soil Studies**  
**TNT and RDX**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ001	-0.4	1.3	20	SVB	62.5	59.1	20	LCS
	-0.6	1.2	20	SVB	58.0	50.8	20	LCS
	-4.8	0.2	20	SVB	63.8	61.8	20	LCS
	-2.1	0.8	20	SVB	56.9	49.0	20	LCS
	-1.9	0.8	20	LCS	64.4	63.1	20	SVB
	-1.2	1.0	20	LCS	56.9	49.0	20	SVB
	5.0	3.4	20	LCS	62.1	58.3	20	SVB
	-6.7	0.0	20	LCS	60.8	55.8	20	SVB
	Average	-1.6	1.1		60.7	55.8		
	St. Dev.	3.4	1.0		3.0	5.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ002	18.6	12.9	20	SVB	32.9	21.2	20	LCS
	15.1	9.8	20	SVB	30.0	18.8	20	LCS
	11.2	6.9	20	SVB	33.5	21.7	20	LCS
	18.7	13.0	20	SVB	28	17.1	20	LCS
	32.2	31.5	20	LCS	41.4	29.2	20	SVB
	27.6	23.8	20	LCS	30.8	19.4	20	SVB
	32.4	31.9	20	LCS	34.8	22.9	20	SVB
	28.8	25.7	20	LCS	34.0	22.2	20	SVB
	17.8	12.2	20	LCS				
	18.0	12.4	20	LCS				
	19	13.3	20	LCS				
	Average	22.0	18.0		33.2	21.6		
	St. Dev.	7.5	9.3		4.0	3.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ003	32.8	32.7	20000	LCS	10.2	3.4	20	LCS
	27.8	24.1	20000	LCS	10.9	4.0	20	LCS
	31.5	30.3	20000	LCS	7.5	0.6	20	LCS
	33.5	34.1	20000	LCS	11.6	4.6	20	LCS
	39.7	48.6	20000	SVB	6.1	0.0	20	LCS
	43.2	59.1	20000	SVB	2.7	0.0	20	LCS
	45.1	65.8	20000	SVB	2.8	0.0	20	LCS
	38.6	45.7	20000	SVB	8.2	1.5	20	LCS
	Average	36.5	42.5		7.5	1.7		
	St. Dev.	6.1	14.7		3.4	1.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ004	45.7	68.0	640	SVB	2.0	0.0	20	LCS
	43.4	59.8	640	SVB	1.6	0.0	20	LCS
	40.2	50.0	640	SVB	1.5	0.0	20	LCS
	43.9	61.5	640	SVB	5.8	0.0	20	LCS
	44.3	62.9	640	SVB	-10.7	0.0	20	LCS
	49.6	84.7	640	SVB	6.4	0.0	20	LCS
	47.0	73.2	640	SVB	4.7	0.0	20	LCS
	44.2	62.5	640	SVB	1.1	0.0	20	LCS
	Average	44.8	65.3		1.6	0.0		
	St. Dev.	2.8	10.3		5.4	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ005	38.9	46.4	2000	SVB	49.8	38.8	20	LCS
	42.8	57.8	2000	SVB	55.7	47.1	21	LCS
	42.7	57.5	2000	SVB	55.7	47.1	22	LCS
	38.3	44.9	2000	SVB	54.5	45.2	23	LCS
	39.4	47.8	2000	SVB	52.2	41.9	24	SVB
	40.9	52.0	2000	SVB	49.8	38.8	25	SVB
	42.6	57.2	2000	SVB	54.8	45.7	26	SVB
	38.7	45.9	2000	SVB	51.6	41.1	27	SVB
	Average	40.5	51.2		53.0	43.2		
	St. Dev.	1.9	5.6		2.5	3.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ006	32.3	31.7	1000	SVB	35.8	23.8	4000	LCS
	29.0	26.0	1000	SVB	40.0	27.8	4000	LCS
	30.6	28.7	1000	SVB	37.4	25.3	4000	LCS
	30.4	28.3	1000	SVB	39.1	26.9	4000	LCS
	34.8	36.7	1000	SVB	59.5	53.4	4000	SVB
	32.5	32.1	1000	SVB	54.3	44.9	4000	SVB
	31.5	30.3	1000	SVB	58.5	51.6	4000	SVB
	26.1	21.7	1000	SVB	56.3	48.0	4000	SVB
					60.1	54.5	4000	LCS
					61.7	57.5	4000	LCS
					59.2	52.8	4000	LCS
					60.4	55.0	4000	LCS
					37.2	25.1	4000	LCS
					58.5	51.6	4000	LCS
					54.3	44.9	4000	LCS
					62.9	59.9	4000	LCS
	Average	30.9	29.4		51.5	43.9		
	St. Dev.	2.6	4.5		10.2	13.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ007	38.1	44.4	1000	SVB	22.7	13.0	200	LCS
	38.7	45.9	1000	SVB	31.7	20.2	200	LCS
	36.0	39.4	1000	SVB	37.5	25.4	200	LCS
	37.7	43.4	1000	SVB	33.7	21.9	200	LCS
	40.2	50.0	1000	SVB	42.2	30.0	200	LCS
	43.5	60.1	1000	SVB	23.8	13.9	200	LCS
	44.5	63.6	1000	SVB	50.0	39.0	200	LCS
	39.3	47.5	1000	SVB	39.0	26.8	200	LCS
					58.7	52.0	200	SVB
					58.3	51.3	200	SVB
					58.6	51.8	200	SVB
					53.2	43.3	200	SVB
					54.8	45.7	200	LCS
					58.5	51.6	200	LCS
					56.1	47.7	200	LCS
					55.2	46.3	200	LCS
	Average	39.8	49.3		45.9	36.2		
	St. Dev.	2.9	8.4		12.9	14.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ008	38.3	44.9	20	SVB	36.8	24.7	4000	SVB
	39.4	47.8	20	SVB	44.6	32.6	4000	SVB
	37.2	42.2	20	SVB	40.1	27.9	4000	SVB
	37.1	41.9	20	SVB	39.2	27.0	4000	SVB
	40.3	50.3	20	LCS	41.5	29.3	4000	SVB
	39.0	46.7	20	LCS	43.9	31.8	4000	SVB
	38.6	45.7	20	LCS	41.9	29.7	4000	SVB
	39.6	48.3	20	LCS	40.4	28.2	4000	SVB
	Average	38.7	46.0		41.1	28.9		
	St. Dev.	1.1	2.9		2.5	2.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ009	14.2	9.1	20	SVB	37.9	25.7	20	SVB
	10.6	6.5	20	SVB	40.6	28.4	20	SVB
	7.2	4.5	20	SVB	40.0	27.8	20	SVB
	11.0	6.8	20	SVB	38.8	26.6	20	SVB
	11.0	6.8	20	LCS	43.3	31.2	20	SVB
	14.2	9.1	20	LCS	39.1	26.9	20	SVB
	8.9	5.5	20	LCS	36.5	24.4	20	SVB
	9.6	5.9	20	LCS	40.5	28.3	20	SVB
	Average	10.8	6.8		39.6	27.4		
	St. Dev.	2.4	1.6		2.0	2.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ010	49.2	82.8	40	SVB	49.1	37.9	60	SVB
	48.3	78.7	40	SVB	57.0	49.1	60	SVB
	47.1	73.6	40	SVB	49.0	37.8	60	SVB
	49.0	81.9	40	SVB	53.1	43.2	60	SVB
	51.4	93.8	40	LCS	51.8	41.4	60	LCS
	48.6	80.1	40	LCS	38.3	26.1	60	LCS
	47.2	74.0	40	LCS	52.7	42.6	60	LCS
	50.1	87.1	40	LCS	46.7	35.0	60	LCS
	Average	48.9	81.5		49.7	39.1		
	St. Dev.	1.4	6.7		5.6	6.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G51-L1-A	41.4	53.5	20	SVB	61.2	56.5	40	LCS
	34.5	36.1	20	SVB	58.5	51.6	40	LCS
	40.9	52.0	20	SVB	60.1	54.5	40	LCS
	39.2	47.2	20	SVB	57.5	49.9	40	LCS
	40.1	49.7	20	SVB	57.4	49.8	40	LCS
	39.7	48.6	20	SVB	61.9	57.9	40	LCS
	31.5	30.3	20	SVB	56.9	49.0	40	LCS
					58.7	52.0	40	LCS
Average	38.2	45.3			59.0	52.6		
St. Dev.	3.7	8.7			1.9	3.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G16-L2-A	23.6	18.4	100	LCS	46.4	34.6	400	LCS
	14.7	9.5	100	LCS	52.9	42.9	400	LCS
	22.9	17.6	100	LCS	47.6	36.0	400	LCS
	36.1	39.6	100	LCS	47.5	35.9	400	LCS
	39.7	48.6	100	SVB	59.8	53.9	400	LCS
	41.0	52.3	100	SVB	58.4	51.5	400	LCS
	35.7	38.7	100	SVB	60.0	54.3	400	LCS
	33.2	33.5	100	LCS	51.8	41.4	400	LCS
	33.3	33.7	100	LCS				
	34.5	36.1	100	LCS				
Average	31.5	32.4			53.1	43.8		
St. Dev.	8.4	14.5			5.7	8.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G55-X-A	15.0	9.7	2000	LCS	57.4	49.8	4000	LCS
	5.2	3.5	2000	LCS	59.1	52.7	4000	LCS
	13.7	8.7	2000	LCS	62.0	58.1	4000	LCS
	31.9	31.0	2000	LCS	60.1	54.5	4000	LCS
	36.9	41.4	2000	SVB	51.2	40.6	4000	LCS
	39.1	47.0	2000	SVB	57.1	49.3	4000	LCS
	31.5	30.3	2000	SVB	52.7	42.6	4000	LCS
	22.7	17.3	2000	LCS	53.5	43.8	4000	LCS
	23.8	18.7	2000	LCS				
	26	21.5	2000	LCS				
Average	24.6	23.1			56.6	48.9		
St. Dev.	10.8	15.2			3.8	6.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G18-L3-A	29.2	26.3	40	LCS	55.6	46.9	200	SVB
	17.0	11.4	40	LCS	58.4	51.5	200	SVB
	26.1	21.7	40	LCS	63.1	60.3	200	SVB
	36.1	39.6	40	LCS	56.3	48.0	200	SVB
	40.5	50.8	40	SVB	47.4	35.8	200	LCS
	40.9	52.0	40	SVB	35.5	23.5	200	LCS
	36.0	39.4	40	SVB	46.5	34.7	200	LCS
	15.0	9.7	40	SVB	44.8	32.8	200	LCS
	18.2	12.5	40	LCS				
	17.8	12.2	40	LCS				
Average	27.7	27.6			51.0	41.7		
St. Dev.	10.3	16.7			9.0	12.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G18-L1-A	40.5	50.8	200	LCS	62.7	59.5	400	LCS
	29.1	26.2	200	LCS	62.3	58.7	400	LCS
	38.9	46.4	200	LCS	62.1	58.3	400	LCS
	34.5	36.1	200	LCS	62.1	58.3	400	LCS
	40.5	50.8	200	SVB	58.7	52.0	400	LCS
	40.3	50.3	200	SVB	66.4	67.7	400	LCS
	33.5	34.1	200	SVB	66.1	67.0	401	LCS
					61.0	56.1	400	LCS
Average	36.8	42.1			62.7	59.7		
St. Dev.	4.5	9.9			2.5	5.3		

## Date: Aug 4 - 8, 1997

[illegible][illegible][illegible][illegible]

[illegible][illegible][illegible][illegible][illegible]



### Umatilla, Flow, RDX, Combine samples

[illegible][illegible]

### Umatilla Army Depot Field Trials

Numbered samples

[illegible]

	<u>FAST 2000</u>	<u>QST 8330</u>	
4_3	BDL *	0.072	
4-111	BDL	94.3	
4-113	BDL	62.6	
4-114	BDL	93.9	(Matrix effect)
4_117	BDL	BDL	
4_24	BDL	BDL	
W0-22	BDL	0.21	
W0-24	BDL	BDL	

\* = Below Detection Limit

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c08	03c08_1.dat	19	27	29	TNT	4.9						
	03c08_2.dat	16	28	63*	TNT	10.8						
	03c08_3.dat	18	27	38	TNT	6.5						
	03c08_4.dat	18	26	32	TNT	5.5						
	03c08_5.dat	11	30	161	TNT	27.5						
	03c08_6.dat	n/a	n/a	o respons	TNT	BDL						
	03c08_6.dat	18	32	99	TNT	16.9						
	03c08_7.dat	17	34	146	TNT	24.9						
	10tnt_7.dat	8	34	59	TNT	10						
	100tnt_1.dat	21	(1)43230	(1030)	TNT	100	13.9	9.4	68%	BDL		
	100tnt_2.dat	20	86	586	TNT	100	**					
	100tnt_3.dat	15	98	371	TNT	100						

\* there was a sharp peak at the beginning

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c10												
	03c10_1.dat	n/a	n/a	none	TNT	BDL						
	03c10_2.dat	n/a	n/a	none	TNT	BDL						
	03c10_3.dat	n/a	n/a	none	TNT	BDL						
	03c10_4.dat	n/a	n/a	none	TNT	BDL						
	03c10_5.dat	n/a	n/a	none	TNT	BDL						
	03c10_6.dat	n/a	n/a	none	TNT	BDL						
	03c10_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_8.dat	21	48	73	TNT	10						
	10tnt_9.dat	20	61	97	TNT	10						
	10tnt_10.dat	19	40	396	TNT	10						
	1ktnt_2.dat	18	87	3692	TNT	1000	BDL			BDL		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c12												
	03c12_1.dat	17	30	97*	TNT	5						
	03c12_2.dat	18	27	60	TNT	3.1						
	03c12_3.dat	16	27	85	TNT	4.4						
	03c12_4.dat	17	26	59	TNT	3						
	03c12_5.dat	17	28	109	TNT	5.6						
	03c12_6.dat	17	32	220	TNT	11.3						
	03c12_7.dat	18	32	208	TNT	10.7						
	10tnt_3.dat	17	46	194	TNT	10 **	6.2	3.4	55%	BDL		
	10tnt_4.dat	17	37	28(?)	TNT	10						
	10tnt_5.dat	18	26	10(?)	TNT	10						

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c17												
	03c17_1.dat	36	50	108*	TNT	3.6						
	03c17_2.dat	35	53	297*	TNT	9.9						
	03c17_3.dat	34	50	255*	TNT	8.5						
	03c17_4.dat	33	47	100*	TNT	3						
	03c17_5.dat	n/a	n/a	none	TNT	BDL						
	03c17_6.dat	37	49	298*	TNT	9.1						
	03c17_7.dat	32	49	275*	TNT	9.1						
	tnt10n1	36	88	927	TNT	10						
	tntn3.dat	35	140	496	TNT	100						
	tnt100n1	39	101	3013	TNT	100 **	7.2	3.1	43%	21.5		
	tnt100n2	37	123	1092	TNT	100						

\* there was a sharp peak at the beginning

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03_34												
	03c17ns1.dat	43	56	298*	TNT	BDL						
	03c17ns2.dat	43	54	142*	TNT	BDL						
	03_34_1a.dat	n/a	n/a	none	TNT	BDL						
	03_34_2.dat	n/a	n/a	none	TNT	BDL						
	03_34_3.dat	n/a	n/a	none	TNT	BDL						
	03_34_4.dat	n/a	n/a	none	TNT	BDL						
	03_34_5.dat	n/a	n/a	none	TNT	BDL						
	03_34_6.dat	n/a	n/a	none	TNT	BDL						
	03_34_7.dat	n/a	n/a	none	TNT	BDL						
	03_34_1.dat(s	36	117	872	TNT	100ng/ml	BDL			BDL		
	tnt4.dat	37	97	3038	TNT	100ng/ml						
	tnt10n2.dat	34	91	764	TNT	10ng/ml						
	tnt100n4.dat	34	104	577	TNT	100ng/ml						
	tnt100n5.dat	35	103	707	TNT	100						

\* there was a sharp peak at the beginning

## 10\_samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_07												
	10_07_1.dat	n/a	n/a	none	TNT	BDL						
	10_07_2.dat	n/a	n/a	none	TNT	BDL						
	10_07_3.dat	n/a	n/a	none	TNT	BDL						
	10_07_4.dat	n/a	n/a	none	TNT	BDL						
	10_07_5.dat	n/a	n/a	none	TNT	BDL						
	10_07_6.dat	n/a	n/a	none	TNT	BDL						
	10_07_7.dat	n/a	n/a	none	TNT	BDL						
	tnt10n1.dat	35	80	83	TNT	10ng/ml						
	tnt100n1.dat	34	87	1739	TNT	100ng/ml	BDL			1.21		
	tnt100n2.dat	37	108	386	TNT	100ng/ml						
	tnt100n3.dat	n/a	n/a	none	TNT	100ng/ml						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_8												
	10-8_1.dat	n/a	n/a	none	TNT	BDL						
	10-8_2.dat	14	26	42	TNT	1.5						
	10-8_3.dat	14	27	71	TNT	2.5						
	10-8_4.dat	17	29	111	TNT	4						
	10-8_5.dat	15	25	155	TNT	5.6						
	10-8_6.dat	18	32	200	TNT	7.2						
	10-8_7.dat	17	33	244	TNT	8.7						
	10tnt_11.dat	19	37	266	TNT	10	4.9	2.8	57%	0.98		
	10tnt_12.dat	20	37	191	TNT	10						
	10tnt_14.dat	20	53	279	TNT	10 **						

\*\* Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_17												
	10-17_1.dat	n/a	n/a	none	TNT	BDL						
	10-17_2.dat	n/a	n/a	none	TNT	BDL						
	10-17_3.dat	n/a	n/a	none	TNT	BDL						
	10-17_4.dat	n/a	n/a	none	TNT	BDL						
	10-17_5.dat	n/a	n/a	none	TNT	BDL						
	10tnt_1.dat	37	78	550	TNT	10ng/ml						
	10tnt_2.dat	41	76	277	TNT	10ng/ml						
	1ktnt_1.dat	39	117	12949	TNT	1000ng/ml	BDL			21.5		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c37												
	10c37_1.dat	n/a	n/a	none	TNT	BDL						
	10c37_2.dat	n/a	n/a	none	TNT	BDL						
	10c37_3.dat	n/a	n/a	none	TNT	BDL						
	10c37_4.dat	n/a	n/a	none	TNT	BDL						
	10c37_5.dat	n/a	n/a	none	TNT	BDL						
	10c37_6.dat	n/a	n/a	none	TNT	BDL						
	10c37_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_18.dat	21	56	86	TNT	10ng/ml						
	10tnt_17.dat	25	59	274	TNT	10ng/ml						
	1tnt_1.dat	-	-	BDL	TNT	1ng/ml						
	1tnt_2.dat	28	66	117	TNT	1ng/ml						
	1ktnt_3.dat	22	73	1227	TNT	-	BDL			BDL		

Spring samples													
Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)	
Spring													
	spr_1.dat	36	60	385	TNT	94.6							
	spr_2.dat	35	59	452	TNT	111							
	spr_3.dat	36	59	442	TNT	108.7							
	spr_4.dat	37	60	436	TNT	107							
	spr_5.dat	35	60	461	TNT	113.3							
	s1000.dat	38	102	1958	TNT	1000							
	spr_6.dat	36	62	569	TNT	139.8							
	spr_7.dat	35	62	539	TNT	132.4							
	tnt10_1.dat	38	98	505?	TNT	10	115	16	####	3.16			
	tnt100_1.dat	-	-	o respons	TNT	100							
	std100_3.dat	37	89	407	TNT	100**							
	tnt100_4.dat	39	74	212	TNT	100							
	st1000_1.dat	35	115	1687	TNT	1000							
** Standard used for Quantitation													

### Umatilla Army Depot, Flow, TNT, EW samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
EW-1	_1dat	33	81		309	11.4	8.25	3.55	43	0.11	N	126	8.25	-175%
	_2dat	40	83		311	11.5								
	_3dat	30	70		162	6								
	_4dat	36	54		117	4.3								
	_5dat	34	70		278	10.3								
	_6dat	45	62		93	3.4								
	_7dat	31	80		294	10.9								
TNT 10	6.dat	39	70		269	10								

[illegible][illegible]

**Umatilla Army Depot, Flow, TNT, SB samples**

[illegible]

**Umatilla Army Depot, Flow, TNT, Combination samples**

[illegible][illegible]

**Umatilla Field Trial (August 4-8, 1997)**  
**Fiber, TNT and RDX, Numbered samples**

**4-x samples**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-2	23.3	14.9	NA	JL	-1.6	0.0	NA	SVB
	1.4	0.0	NA	JL	-12.8	0.0	NA	SVB
	-6.0	0.0	NA	JL	-45.1	0.0	NA	SVB
	-27.1	0.0	NA	SVB	-35.6	0.0	NA	SVB
	-7.7	0.0	NA	SVB	-59.2	0.0	NA	SVB
	26.1	17.5	NA	SVB	-36.8	0.0	NA	SVB
	-23.6	0.0	NA	KD	-71.9	0.0	NA	SVB
	-12.6	0.0	NA	KD	-64.2	0.0	NA	SVB
	-19.4	0.0	NA	KD	8.5	1.8	NA	SVB
	-10.3	0.0	NA	KD	-32.0	0.0	NA	LA
	4.0	0.0	NA	LA	-51.0	0.0	NA	LA
	-9.0	0.0	NA	LA				
	4.0	0.0	NA	LA				
	-16.0	0.0	NA	LA				
Average	-5.2	2.3			-36.5	0.2		
St. Dev.	15.6	5.9			25.6	0.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-3	17.2	9.9	NA	JL	21.0	11.7	1:10	KD
	17.6	10.2	NA	JL	33.1	21.4	1:10	KD
	21.7	13.5	NA	JL	29.7	18.5	1:10	KD
	20.2	12.3	NA	JL	19.2	10.4	1:10	KD
	28.1	19.4	NA	SVB	32.6	21.0	1:10	GF
	26.6	18.0	NA	SVB	28.8	17.8	1:10	GF
	35.9	28.3	NA	SVB	30.1	18.9	1:10	GF
	26.5	17.9	NA	SVB				
	-11.0	0.0	NA	GF				
	-10.0	0.0	NA	GF				
	-7.0	0.0	NA	GF				
	-10.0	0.0	NA	GF				
	20.0	12.1	NA	KD				
	12.0	5.8	NA	KD				
	0.0	0.0	NA	KD				
	0.0	0.0	NA	KD				
Average	11.7	9.2			17.1			
St. Dev.	15.7	8.9			4.3			

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-7					-13.2	0.0	1:50	SVB
					10.5	3.6	1:50	SVB
					9.1	2.4	1:50	SVB
					13.4	6.0	1:50	SVB
					-26.8	0.0	1:50	SVB
					-34.0	0.0	1:50	SVB
					-9.8	0.0	1:50	SVB
					-5.1	0.0	1:50	SVB
Average					-7.0	1.5		
St. Dev.					17.5	2.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-7	25.4	16.8	NA	SVB	89.5	221.4	NA	GF
	32.8	24.5	NA	SVB	87.7	190.7	NA	GF
	31.4	22.9	NA	SVB	79.5	116.2	NA	GF
	40.2	34.5	NA	SVB	87.3	185.0	NA	GF
	11.3	5.3	NA	SVB	95.0	454.0	NA	LA
	20.2	12.3	NA	SVB	98.4	2418.6	NA	LA
	21.4	13.3	NA	SVB	91.8	279.7	NA	LA
	30.0	21.4	NA	SVB	97.9	1348.6	NA	LA
	-1.6	0.0	NA	GF				
	-14.0	0.0	NA	GF				
	-20.0	0.0	NA	GF				
	-7.0	0.0	NA	GF				
	1.0	0.0	NA	LA				
	14.0	7.4	NA	LA				
	6.0	0.9	NA	LA				
	40.0	34.2	NA	LA				
Average	14.4	12.1			90.9	651.8		
St. Dev.	18.9	12.4			6.3	818.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-7					21.5	12.1	1:10	IB
					31.5	20.0	1:10	IB
					18.6	9.9	1:10	IB
					20.3	11.2	1:10	IB
					28.3	17.4	1:10	IB
					32.1	20.5	1:10	IB
					23.2	13.4	1:10	IB
					29.3	18.2	1:10	IB
Average					25.6	15.3		
St. Dev.					5.3	4.2		

**4- 1xx samples**

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-102	66.5	162.3	NA	GF				
	66.0	154.3	NA	GF				
	71.6	347.5	NA	GF				
	73.3	586.4	NA	GF				
	79.2	#NUM!	NA	LA				
	74.1	907.9	NA	LA				
	82.4	#NUM!	NA	LA				
	68.5	204.7	NA	LA				
Average	72.7	#NUM!						
St. Dev.	5.9	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-102	27.7	19.0	1:10	SVB	49.3	38.1	1:10	GF
	19.2	11.5	1:10	SVB	47.2	35.6	1:10	GF
	27.1	18.5	1:10	SVB	38.3	26.1	1:10	GF
	29.2	20.6	1:10	SVB	35.0	23.1	1:10	LA
	27.1	18.5	1:10	SVB	34.0	22.2	1:10	LA
	30.4	21.8	1:10	SVB	41.0	28.8	1:10	LA
					51.0	40.3	1:10	LA
Average	26.8	18.3			42.3	30.6		
St. Dev.	3.9	3.6			6.9	7.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-111	58.0	84.0	NA	AZ	-39.0	0.0	1:50	LA*
	46.0	45.0	NA	AZ	36.0	24.0	1:50	GF
	50.0	54.5	NA	AZ	3.2	0.0	1:50	LA*
	61.0	102.2	NA	AZ	9.1	2.4	1:50	LA*
	54.9	70.2	NA	GF	3.7	0.0	1:50	GF
	55.4	72.2	NA	GF	-11.0	0.0	1:50	GF
	60.0	95.4	NA	GF	29.4	18.3	1:50	GF
	58.2	85.0	NA	GF	-5.0	0.0	1:50	GF
					-6.8	0.0	1:50	SVB
					10.4	3.6	1:50	SVB
					13.3	5.9	1:50	SVB
					7.1	0.0	1:50	SVB
					-0.6	0.0	1:50	SVB
					12.1	5.0	1:50	SVB
					12.4	5.2	1:50	SVB
					16.9	8.7	1:50	SVB
Average	55.4	76.1			5.7	4.6		
St. Dev.	5.1	19.6			17.1	7.1		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-112	80.8	#NUM!	NA	SVB	28.3	17.4	NA	GF
	87.0	#NUM!	NA	SVB	38.5	26.3	NA	GF
	85.9	#NUM!	NA	SVB	30.1	18.9	NA	GF
	86.2	#NUM!	NA	SVB	43.9	31.8	NA	GF
	100.0	#NUM!	NA	KD/AZ	36.0	24.0	NA	KD
	47.1	47.4	NA	KD/AZ	26.9	16.3	NA	KD
	26.4	17.8	NA	KD/AZ	28.4	17.5	NA	KD
	41.0	35.8	NA	AZ	24.7	14.6	NA	KD
	65.0	140.3	NA	AZ				
	58.0	84.0	NA	AZ				
	24.0	15.6	NA	AZ				
Average	63.8	#NUM!			32.1	20.8		
St. Dev.	26.4	#NUM!			6.6	5.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-112	38.5	31.9	1:10	SVB				
	40.8	35.4	1:10	SVB				
	38.3	31.6	1:10	SVB				
	28.9	20.3	1:10	SVB				
	49.2	52.4	1:10	JL				
	44.0	41.0	1:10	JL				
	42.7	38.6	1:10	JL				
	44.4	41.8	1:10	JL				
Average	40.9	36.6						
St. Dev.	6.0	9.4						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-112	-7.0	0.0	1:50	GF				
	-13.0	0.0	1:50	GF				
	-2.0	0.0	1:50	GF				
	-6.0	0.0	1:50	GF				
Average	-7.0	0.0						
St. Dev.	4.5	0.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-113	68.0	192.2	NA	KD	-53.6	0.0	NA	SVB
	66.0	154.3	NA	KD	-46.1	0.0	NA	SVB
	62.0	109.8	NA	KD	-0.4	0.0	NA	SVB
	60.0	95.4	NA	LA	-7.0	0.0	NA	SVB
	59.0	89.4	NA	LA	-8.0	0.0	NA	AZ
	62.0	109.8	NA	LA	-6.0	0.0	NA	AZ
	54.0	66.9	NA	LA	-4.0	0.0	NA	AZ
					-4.0	0.0	NA	AZ
					42.1	29.9	NA	GF
					37.8	25.6	NA	GF
					44.5	32.5	NA	GF
					34.7	22.8	NA	GF
Average	61.6	116.8			2.5	9.2		
St. Dev.	4.6	42.6			32.3	13.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-24	12.4	6.2	NA	SVB	64.4	63.1	NA	GF
	8.1	2.8	NA	SVB	71.0	80.4	NA	GF
	0.5	0.0	NA	SVB	59.7	53.7	NA	GF
	-30.2	0.0	NA	SVB	62.0	58.1	NA	GF
	-19.8	0.0	NA	SVB	72.0	83.6	NA	LA
	-16.0	0.0	NA	SVB	70.9	80.1	NA	LA
	-22.5	0.0	NA	SVB	77.4	105.1	NA	LA
	-13.0	0.0	NA	LA	74.1	91.0	NA	LA
	-6.0	0.0	NA	LA				
	-24.0	0.0	NA	LA				
	-4.0	0.0	NA	LA				
	-11.4	0.0	NA	SVB				
	9.2	3.7	NA	SVB				
	-8.6	0.0	NA	SVB				
Average	-9.0	0.9			68.9	76.9		
St. Dev.	13.2	1.9			6.2	17.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-25	9.4	3.8	NA	GF	36.8	24.7	NA	GF
	9.6	4.0	NA	GF	40.0	27.8	NA	GF
	0.9	0.0	NA	GF	46.5	34.7	NA	GF
	3.6	0.0	NA	GF	53.4	43.6	NA	GF
	19.0	11.3	NA	LA	36.0	24.0	NA	KD
	26.0	17.4	NA	LA	27.4	16.7	NA	KD
	24.0	15.6	NA	LA	32.4	20.8	NA	KD
	28.0	19.3	NA	LA	32.9	21.2	NA	KD
Average	15.1	8.9			38.2	26.7		
St. Dev.	10.5	7.9			8.4	8.7		

#### SB\_009 samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
SB-3	-20.4	0.0	NA	SVB	4.1	0.0	NA	SVB
	-12.8	0.0	NA	SVB	27.4	16.7	NA	SVB
	-7.5	0.0	NA	SVB	-5.7	0.0	NA	SVB
	-10.1	0.0	NA	SVB	6.2	0.0	NA	SVB
	-11.3	0.0	NA	KD	9.7	2.9	NA	SVB
	-4.2	0.0	NA	KD	-6.8	0.0	NA	SVB
	-34.9	0.0	NA	KD	-6.3	0.0	NA	SVB
	-4.5	0.0	NA	KD	-14.0	0.0	NA	AZ
	-9.0	0.0	NA	GF	13.0	5.7	NA	AZ
	-9.0	0.0	NA	GF	-19.0	0.0	NA	AZ
	-5.0	0.0	NA	GF	24.0	14.0	NA	AZ
	1.0	0.0	NA	GF	39.8	27.6	NA	LA
					31.5	20.0	NA	LA
					33.5	21.7	NA	LA
					33.2	21.5	NA	LA
Average	-10.6	0.0			11.4	8.7		
St. Dev.	9.3	0.0			19.2	10.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
009	66.8	167.5	NA	GF				
	64.6	135.4	NA	GF				
	64.6	135.4	NA	GF				
	65.9	152.8	NA	GF				
	51.0	57.2	NA	KD				
	55.0	70.6	NA	KD				
	55.0	70.6	NA	KD				
	63.0	118.5	NA	KD				
Average	60.7	113.5						
St. Dev.	6.1	41.9						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
009	21.4	13.3	1:50	SVB	19.2	10.4	1:50	GF
	36.2	28.7	1:50	SVB	16.1	8.1	1:50	GF
	36.6	29.3	1:50	SVB	28.1	17.2	1:50	GF
	43.2	39.5	1:50	SVB	10.4	3.6	1:50	KD
					6.4	0.0	1:50	KD
					17.2	8.9	1:50	KD
					20.7	11.5	1:50	KD
Average	34.4	27.7			16.9	8.5		
St. Dev.	9.2	10.8			7.1	5.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-113	6.0	0.9	1:50	LA				
	4.0	0.0	1:50	LA				
	2.0	0.0	1:50	LA				
	-9.0	0.0	1:50	LA				
	-21.0	0.0	1:50	GF				
	-27.0	0.0	1:50	GF				
	-18.0	0.0	1:50	GF				
	-15.0	0.0	1:50	GF				
Average	-9.8	0.1						
St. Dev.	12.5	0.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-114	50.2	55.0	NA	SVB	19.6	10.7	NA	SVB
	65.1	141.6	NA	SVB	-15.1	0.0	NA	SVB
	61.5	105.9	NA	SVB	1.0	0.0	NA	SVB
	32.8	24.5	NA	SVB	29.5	18.4	NA	SVB
	33.6	25.5	NA	SVB	-1.7	0.0	NA	SVB
	27.8	19.1	NA	SVB	-9.8	0.0	NA	SVB
	28.9	20.3	NA	SVB	17.0	8.7	NA	SVB
	26.0	17.4	NA	JL	16.7	8.5	NA	SVB
	60.3	97.4	NA	JL	37.5	25.4	NA	GF
	49.8	53.9	NA	JL	25.4	15.1	NA	GF
	57.3	80.5	NA	JL	28.9	17.9	NA	GF
					24.9	14.7	NA	GF
					-2.0	0.0	NA	LA
					-12.0	0.0	NA	LA
					10.2	3.4	NA	LA
					-24.0	0.0	NA	LA
Average	44.8	58.3			9.1	7.7		
St. Dev.	15.2	42.6			18.5	8.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-114	-26.0	0.0	1:50	LA				
	-37.0	0.0	1:50	LA				
	-8.0	0.0	1:50	LA				
	-123.0	0.0	1:50	LA				
	9.0	3.5	1:50	LA				
	4.0	0.0	1:50	LA				
	12.0	5.8	1:50	LA				
	0.0	0.0	1:50	LA				
Average	-21.1	1.2						
St. Dev.	44.6	2.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-114D	42.6	38.5	1:50	KD	7.0	0.0	1:50	KD
	57.6	82.0	1:50	KD	8.4	1.7	1:50	KD
	54.0	66.9	1:50	KD	13.0	5.7	1:50	KD
	49.0	51.9	1:50	LA	-9.8	0.0	1:50	KD
	50.0	54.5	1:50	LA	37.0	24.9	1:50	AZ
	50.0	54.5	1:50	LA	30.0	18.8	1:50	AZ
	45.0	42.9	1:50	LA	36.0	24.0	1:50	AZ
Average	49.7	55.9			17.4	10.7		
St. Dev.	5.1	14.7			17.5	11.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-117	46.3	45.6	NA	?	43.0	30.8	1:10	LA
	68.3	199.5	NA	?	35.0	23.1	1:10	LA
	68.4	202.1	NA	?	44.0	31.9	1:10	LA
	66.2	157.4	NA	?	32.0	20.4	1:10	LA
	36.5	29.1	NA	SVB	6.9	0.0	1:10	KD
	49.8	53.9	NA	SVB	37.6	25.4	1:10	KD
	51.3	58.1	NA	SVB	34.4	22.5	1:10	KD
	62.4	113.1	NA	SVB				
	0.0	0.0	NA	AZ/KD				
	19.0	11.3	NA	AZ/KD				
	0.0	0.0	NA	AZ/KD				
	9.0	3.5	NA	GF				
	7.0	1.9	NA	GF				
	9.0	3.5	NA	GF				
	0.0	0.0	NA	GF				
Average	32.9	58.6			33.3	22.0		
St. Dev.	27.5	73.7			12.4	10.6		

## Umatilla, Fiber, TNT and RDX, EW samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-1	63.4	122.3	NA	SVB	25.7	15.3	1:50	GF/AZ
	80.4	#NUM!	NA	SVB	27.3	16.6	1:50	GF/AZ
	75.6	#NUM!	NA	SVB	29.2	18.1	1:50	GF/AZ
	80.4	#NUM!	NA	SVB	27.7	16.9	1:50	GF/AZ
	54.7	69.4	NA	SVB	21.9	12.4	1:50	LA
	74.6	1460.0	NA	SVB	19.0	10.2	1:50	LA
	77.3	#NUM!	NA	SVB	16.3	8.2	1:50	LA
	74.6	1460.0	NA	SVB				
	44.8	42.5	NA	SVB				
	6.0	0.9	NA	SVB				
	39.9	34.0	NA	SVB				
Average	61.1	#NUM!			23.9	14.0		
St. Dev.	23.2	#NUM!			4.9	3.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-3	68.4	202.1	NA	LA				
	72.0	383.1	NA	LA				
	84.0	#NUM!	NA	LA				
	70.0	254.9	NA	LA				
Average	73.6	#NUM!						
St. Dev.	7.1	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-3	69.0	219.1	1:50	GF	7.0	0.0	1:50	LA
	74.0	847.3	1:50	GF	12.0	4.9	1:50	LA
	81.0	#NUM!	1:50	GF	-15.0	0.0	1:50	LA
	83.0	#NUM!	1:50	GF	-31.0	0.0	1:50	AZ
					-4.0	0.0	1:50	AZ
Average	76.8	#NUM!			-6.2	1.0		
St. Dev.	6.4	#NUM!			17.3	2.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-3	8.9	3.5	1:100	SVB				
	8.8	3.4	1:100	SVB				
	16.9	9.6	1:100	SVB				
	17.8	10.3	1:100	SVB				
	48.5	50.6	1:100	SVB				
	27.4	18.8	1:100	SVB				
	29.1	20.5	1:100	SVB				
Average	22.5	16.7						
St. Dev.	14.0	16.4						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-4	-94.9	0.0	NA	SVB				
	-57.3	0.0	NA	SVB				
	-12.0	0.0	NA	SVB				
	-6.0	0.0	NA	SVB				
	31.1	22.6	NA	SVB				
	32.1	23.7	NA	SVB				
	29.4	20.8	NA	SVB				
	2.0	0.0	NA	SVB				
	-3.9	0.0	NA	SVB				
	-0.2	0.0	NA	SVB				
	-17.0	0.0	NA	SVB				
	-13.0	0.0	NA	SVB				
	-5.0	0.0	NA	SVB				
	-17.0	0.0	NA	SVB				
Average	-9.4	4.8						
St. Dev.	33.8	9.5						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-4					81.0	125.4	1:50	LA
					84.0	148.4	1:50	LA
					74.0	90.7	1:50	LA
					91.0	256.1	1:50	LA
					-21.0	0.0	1:50	AZ
					33.0	21.3	1:50	AZ
Average					47.4	91.7		
St. Dev.					47.0	94.1		

## Umatilla, Fiber, RDX and TNT, WO samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
WO-21	13.0	6.6	NA	KD	89.0	211.9	NA	AZ
	6.0	0.9	NA	KD	99.0	#NUM!	NA	AZ
	0.0	0.0	NA	KD	100.0	#NUM!	NA	AZ
	0.0	0.0	NA	KD	94.4	404.9	NA	KD
	11.7	5.6	NA	GF	95.1	463.5	NA	KD
	16.5	9.3	NA	GF	93.9	372.0	NA	KD
	12.2	6.0	NA	GF	91.7	276.5	NA	KD
	7.4	2.2	NA	GF				
Average	8.4	3.8			94.7	#NUM!		
St. Dev.	6.1	3.5			3.9	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
WO-21					40.8	28.6	1:10	IB
					49.6	38.6	1:10	IB
					41.1	28.8	1:10	IB
					38.3	26.1	1:10	IB
					36.0	23.9	1:10	IB
					37.1	25.0	1:10	IB
					31.2	19.8	1:10	IB
					42.1	29.9	1:10	IB
Average					39.5	27.6		
St. Dev.					5.4	5.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
WO22	81.5	#NUM!	NA	GF	9.0	2.3	NA	SVB
	77.5	#NUM!	NA	GF	0.7	0.0	NA	SVB
	80.0	#NUM!	NA	GF	21.6	12.2	NA	SVB
	82.6	#NUM!	NA	GF	-8.9	0.0	NA	SVB
	59.3	91.1	NA	LA*est	24.0	14.0	NA	SVB
	57.0	79.1	NA	LA*est	-2.5	0.0	NA	SVB
	66.0	154.3	NA	LA*est	-1.5	0.0	NA	SVB
	66.0	154.3	NA	LA*est	22.4	12.8	NA	SVB
					54.7	45.5	NA	KD
					39.8	27.6	NA	KD
					44.8	32.8	NA	KD
					29.4	18.3	NA	KD
Average	71.2	#NUM!			19.5	13.8		
St. Dev.	10.4	#NUM!			20.5	15.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
WO22	36.5	29.1	1:10	SVB				
	27.7	19.0	1:10	SVB				
	31.0	22.5	1:10	SVB				
	31.9	23.5	1:10	SVB				
	-3.0	0.0	1:10	JL				
	-4.0	0.0	1:10	JL				
	0.0	0.0	1:10	JL				
	-4.5	0.0	1:10	JL				
Average	14.5	11.8						
St. Dev.	18.7	12.9						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
WO24	15.5	8.5	NA	SVB	84.0	378.1	NA	AZ
	33.7	25.6	NA	SVB	99.0	#NUM!	NA	AZ
	30.7	22.2	NA	SVB	54.0	44.5	NA	AZ
	40.9	35.6	NA	SVB	92.6	308.4	NA	KD
	30.5	21.9	NA	JL	91.5	270.3	NA	KD
	32.6	24.3	NA	JL	96.9	772.4	NA	KD
	35.2	27.4	NA	JL	90.7	248.3	NA	KD
	34.2	26.2	NA	JL				
	35.8	28.2	NA	GL				
	26.8	18.2	NA	GL				
	31.7	23.3	NA	GL				
	31.1	22.6	NA	GL				
	6.8	1.7	NA	KD				
	18.6	11.0	NA	KD				
	-12.7	0.0	NA	KD				
	-26.3	0.0	NA	KD				
Average	22.8	18.5			88.4	#NUM!		
St. Dev.	18.8	10.9			15.4	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
WO-24					-2.4	0.0	1:50	SVB
					18.2	9.6	1:50	SVB
					16.0	8.0	1:50	SVB
					16.2	8.1	1:50	SVB
					20.5	11.4	1:50	SVB
					26.6	16.0	1:50	SVB
					16.7	8.5	1:50	SVB
Average					16.0	8.8		
St. Dev.					8.9	4.8		

## Umatilla, Fiber, RDX and TNT, Combine samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 1					67.3	70.0	1:10	GF
					65.5	65.6	1:10	GF
					59.4	53.2	1:10	GF
					59.5	53.4	1:10	SVB
					62.8	59.7	1:10	SVB
					69.6	76.2	1:10	SVB
					51.4	40.9	1:10	SVB
Average					62.2	59.8		
St. Dev.					6.1	11.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 1	54.1	67.2	1:50	GF	30.0	18.8	1:50	LA*
	48.3	50.1	1:50	GF	-2.0	0.0	1:50	GF
	49.7	53.7	1:50	GF	-3.0	0.0	1:50	GF
	54.4	68.3	1:50	GF	51.0	40.3	1:50	SVB
	26.0	17.4	1:50	KD/AZ				
	19.0	11.3	1:50	KD/AZ				
	31.0	22.5	1:50	KD/AZ				
	12.0	5.8	1:50	KD/AZ				
Average	36.8	37.0			19.0	14.8		
St. Dev.	16.9	25.5			26.3	19.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 2	57.0	79.1	1:50	LA	-30.2	0.0	1:50	KD
	59.0	89.4	1:50	LA	-4.7	0.0	1:50	KD
	56.0	74.7	1:50	LA	12.6	5.4	1:50	KD
	59.0	89.4	1:50	LA	7.6	0.7	1:50	KD
	45.0	42.9	1:50	KD				
	45.0	42.9	1:50	KD				
	54.0	66.9	1:50	KD				
	49.0	51.9	1:50	KD				
Average	53.0	67.1			-3.7	1.5		
St. Dev.	5.9	19.3			19.1	2.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 2					55.7	47.1	1:10	SVB
					56.8	48.8	1:10	SVB
					60.9	56.0	1:10	SVB
					45.4	33.5	1:10	SVB
					78.0	108.1	1:10	GF
					82.5	136.0	1:10	GF
					68.6	73.4	1:10	GF
Average					64.0	71.8		
St. Dev.					13.1	37.2		

## Umatilla, Fiber, TNT and RDX, Standards

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-2	42.6	38.5	NA	JSL				
	33.4	25.2	NA	JSL				
	17.8	10.3	NA	JSL				
	17.4	10.0	NA	JSL				
	5.3	0.1	NA	SVB				
	-3.1	0.0	NA	SVB				
	-1.3	0.0	NA	SVB				
	-18.9	0.0	NA	SVB				
	3.0	0.0	NA	LA				
	12.0	5.8	NA	LA				
	12.0	5.8	NA	LA				
	-39.0	0.0	NA	LA				
	58.0	84.0	NA	KD				
	49.0	51.9	NA	KD				
	31.0	22.5	NA	KD				
	35.0	27.2	NA	KD				
Average	15.9	17.6						
St. Dev.	25.4	23.7						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-3	42.2	37.8	NA	?				
	41.9	37.3	NA	?				
	36.5	29.1	NA	?				
	46.2	45.4	NA	?				
	40.0	34.2	NA	SVB				
	41.3	36.3	NA	SVB				
	37.0	29.8	NA	SVB				
	25.8	17.2	NA	GF				
	29.9	21.3	NA	GF				
	31.0	22.5	NA	KD				
	42.0	37.4	NA	KD				
	40.0	34.2	NA	KD				
Average	37.8	31.9						
St. Dev.	6.0	8.2						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-7					-10.1	0.0	NA	SVB*
					-1.5	0.0	NA	SVB*
					32.5	20.9	NA	SVB*
					69.6	76.2	NA	SVB*
					14.4	6.8	NA	SVB
					18.3	9.7	NA	SVB
					6.0	0.0	NA	SVB
					27.1	16.4	NA	SVB
					11.9	4.8	NA	GF
					21.0	11.7	NA	GF
					4.0	0.0	NA	GF
					22.8	13.1	NA	GF
					20.0	11.0	NA	KD
					51.0	40.3	NA	KD
					56.0	47.5	NA	KD
					52.0	41.7	NA	KD
					24.7	18.8		
Average					22.4	21.8		
St. Dev.								

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-8					88.0	195.2	NA	LA
					82.0	132.2	NA	LA
					78.0	108.1	NA	LA
					76.0	98.7	NA	LA
					53.0	43.1	NA	GF
					55.0	46.0	NA	GF
					46.0	34.2	NA	GF
					54.0	44.5	NA	GF
					66.5	87.8		
					16.1	56.8		
Average								
St. Dev.								